pennsylvania
DEPARTMENT OF ENVIRONMENTAL
PROTECTION

MEMO

TO   Brian Halchak
            Air Quality Program
            Northeast Regional Office (NERO)

FROM   Darren Lauer   D.T.L
            Air Quality Specialist
            Source Testing Section
            Division of Source Testing and Monitoring

THROUGH Charles Zadakis
            Chief
            Division of Source Testing and Monitoring

            Rick Begley
            Chief
            Source Testing Section
            Division of Source Testing and Monitoring

DATE   April 10, 2014

RE   Source Test Review
            UGI Development Company
            Hunlock Creek Energy Center (HCEC)
            Combined Cycle Combustion Turbine Unit
            Nos. 5 & 6, Source ID's CT5 & CT6, respectively
            Hunlock Township, Luzerne County
            Plan Approval No. 40-328-006
            eFacts ID No. 2217681
            PFID No. 284013

UGI Development Company operates two 50 Megawatt (MW) GE LM 6000 PC-Sprint combustion turbine generators (CTG's) identified as CTG Units 5 & 6 (ID's CT5 & CT6, respectively) and two associated natural gas fired heat recovery steam generators (HRSG's) identified as Units 5 & 6 HRSG's (ID's DB5 & DB6, respectively) at its HCEC Facility. The sources and their associated control units were described in detail in the previous memo for testing in August 2012.

During August 14 to 20, 2013, Avogadro Environmental Corporation performed compliance testing for combustion turbine nos. 5 & 6 in accordance with the plan approval. Testing was conducted to determine total particulate matter < 10 microns in aerodynamic diameter (filterable PM < 2.5 microns in aerodynamic diameter (FPM$_{2.5}$), filterable PM < 10 microns in aerodynamic diameter (FPM$_{10}$), and condensable PM (CPM)), ammonia (NH$_3$), volatile organic compounds (VOC), nitrogen oxides (NOx), and carbon monoxide (CO) emissions from the turbine exhaust. During testing, EPA Methods 1, 2, 3A, 4, 7E, 10, 18/ 25A, 201A, 202, and 320 (for ammonia testing) were used.

FPM$_{2.5}$, FPM$_{10}$, CPM, Total PM$_{2.5}$, Total PM$_{10}$, NOx, CO, & VOC Test Results for CT5 - No Duct Burners Firing:

Test Date: 8/14/13				
Run Number	1	2	3	Avg.
Oxygen (%)	14.3	14.3	14.3	14.3
FPM$_{2.5}$ Emission Concentration (gr/dscf)	0.0008	0.0009	0.0005	0.0007
FPM$_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0031	0.0034	0.0022	0.0029
FPM$_{10}$ Emission Concentration (gr/dscf)	0.0023	0.0012	0.0019	0.0018
FPM$_{10}$ Mass Emission Rate (lbs/MMBtu)	0.0092	0.0049	0.0076	0.0072
CPM Emission Concentration (gr/dscf)	0.0009	0.0009	0.0010	0.0009
CPM Mass Emission Rate (lbs/MMBtu)	0.0037	0.0034	0.0038	0.0036
Total PM$_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0068	0.0068	0.0060	0.0065
Total PM$_{2.5}$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
Total PM$_{10}$ Emission Concentration (gr/dscf)	0.0033	0.0021	0.0029	0.0028
Total PM$_{10}$ Mass Emission Rate (lbs/MMBtu)	0.0129	0.0083	0.0114	0.0109
Total PM$_{10}$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
NOx Emission Concentration (ppmdv)	2.6	2.5	2.6	2.6
NOx Emission Concentration (ppmdv, at 15 % O$_2$)	2.3	2.3	2.3	2.3
NOx Allowable Emission Concentration (ppmdv, at 15 % O$_2$)	2.5			
CO Emission Concentration (ppmdv)	3.3	3.4	3.4	3.4
CO Emission Concentration (ppmdv, at 15 % O$_2$)	3.0	3.0	3.0	3.0
CO Allowable Emission Concentration (ppmdv, at 15 % O$_2$)	4.0			
VOC Emission Concentration (ppmdv, as C$_3$H$_8$)	< 0.33	< 0.33	< 0.33	< 0.33
VOC Emission Concentration (ppmdv, as C$_3$H$_8$ at 15 % O$_2$)	< 0.30	< 0.30	< 0.30	< 0.30
VOC Allowable Emission Concentration (ppmdv, as C$_3$H$_8$ at 15 % O$_2$)	1.2			

H$_2$SO$_4$ Mists & SO$_2$ * Test Results Test Results for CT5 - No Duct Burners Firing:

Test Date: 8/14/13				
Run Number	1	2	3	Avg.
H$_2$SO$_4$ Mists Mass Emission Rate (lbs/MMBtu, as H$_2$SO$_4$)*	0.00016 [1]			
H$_2$SO$_4$ Mists Allowable Mass Emission Rate (lbs/MMBtu, as H$_2$SO$_4$)	0.0009			
SO$_2$ Mass Emission Rate (lbs/MMBtu)*	0.00011 [1]			
SO$_2$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0030			

* data based on fuel sample sulfur analysis for the fuel fired during testing as noted previously

FPM$_{2.5}$, FPM$_{10}$, CPM, Total PM$_{2.5}$, Total PM$_{10}$, NOx, CO, & VOC Test Results for CT5 - With Duct Burners Firing:

Test Date: 8/15/13				
Run Number	1	2	3	Run 2 & 3 Avg. **
Oxygen (%)	13.8	13.8	13.8	13.8
FPM$_{2.5}$ Emission Concentration (gr/dscf)	0.0030	0.00065	0.00005	0.0004
FPM$_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0109	0.0024	0.0002	0.0013
FPM$_{10}$ Emission Concentration (gr/dscf)	0.0030	0.0027	0.0001	0.0014
FPM$_{10}$ Mass Emission Rate (lbs/MMBtu)	0.0110	0.0097	0.0005	0.0051
CPM Emission Concentration (gr/dscf)	0.022	0.0007	0.0008	0.0008
CPM Mass Emission Rate (lbs/MMBtu)	0.0807	0.0027	0.0029	0.0028
Total PM$_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0916	0.0051	0.0031	0.0041
Total PM$_{2.5}$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
Total PM$_{10}$ Emission Concentration (gr/dscf)	0.025	0.0034	0.0009	0.0022
Total PM$_{10}$ Mass Emission Rate (lbs/MMBtu)	0.0917	0.0124	0.0034	0.0079
Total PM$_{10}$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
NOx Emission Concentration (ppmdv)	3.0	2.9	2.9	3.0
NOx Emission Concentration (ppmdv, at 15 % O$_2$)	2.5	2.4	2.4	2.4
NOx Allowable Emission Concentration (ppmdv, at 15 % O$_2$)	2.9			
CO Emission Concentration (ppmdv)	4.4	4.3	4.4	4.3
CO Emission Concentration (ppmdv, at 15 % O$_2$)	3.6	3.5	3.6	3.6
CO Allowable Emission Concentration (ppmdv, at 15 % O$_2$)	4.0			
VOC Emission Concentration (ppmdv, as C$_3$H$_8$)	0.31	0.41	0.33	0.35
VOC Emission Concentration (ppmdv, as C$_3$H$_8$ at 15 % O$_2$)	0.26	0.34	0.28	0.29
VOC Allowable Emission Concentration (ppmdv, as C$_3$H$_8$ at 15 % O$_2$)	1.2			

** PM sampling continued to be performed for about 5 minutes during and after CT5 unexpectedly shut down during test run 1. The Run 1 shaded data was reported as unrepresentative of actual emissions during normal/non-shutdown conditions due to catching excessive particulate in the train during the shutdown period. The permit conditions also state that the limits do not apply during shutdown or startup CT operations. The average for Runs 2 & 3 was reported and is valid under 40 CFR 60.8 (f) for compliance purposes.

$FPM_{2.5}$, FPM_{10}, CPM, Total $PM_{2.5}$, Total PM_{10}, NOx, CO, & VOC Test Results for CT6 - No Duct Burners Firing:

Test Date: 8/19/13				
Run Number	1	2	3	Avg.
Oxygen (%)	14.2	14.2	14.2	14.2
$FPM_{2.5}$ Emission Concentration (gr/dscf)	0.0008	0.0004	0.0009	0.0007
$FPM_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0031	0.0015	0.0036	0.0027
FPM_{10} Emission Concentration (gr/dscf)	0.0009	0.0009	0.0010	0.0009
FPM_{10} Mass Emission Rate (lbs/MMBtu)	0.0034	0.0034	0.0037	0.0035
CPM Emission Concentration (gr/dscf)	0.0010	0.0007	0.0004	0.0007
CPM Mass Emission Rate (lbs/MMBtu)	0.0040	0.0027	0.0016	0.0028
Total $PM_{2.5}$ Mass Emission Rate (lbs/MMBtu)	0.0071	0.0042	0.0052	0.0055
Total $PM_{2.5}$ Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
Total PM_{10} Emission Concentration (gr/dscf)	0.0019	0.0016	0.0014	0.0016
Total PM_{10} Mass Emission Rate (lbs/MMBtu)	0.0075	0.0061	0.0053	0.0063
Total PM_{10} Allowable Mass Emission Rate (lbs/MMBtu)	0.0141			
NOx Emission Concentration (ppmdv)	2.6	2.6	2.5	2.6
NOx Emission Concentration (ppmdv, at 15 % O_2)	2.3	2.3	2.2	2.3
NOx Allowable Emission Concentration (ppmdv, at 15 % O_2)	2.5			
CO Emission Concentration (ppmdv)	2.9	3.0	3.2	3.1
CO Emission Concentration (ppmdv, at 15 % O_2)	2.6	2.7	2.8	2.7
CO Allowable Emission Concentration (ppmdv, at 15 % O_2)	4.0			
VOC Emission Concentration (ppmdv, as C_3H_8)	< 0.33	< 0.33	< 0.33	< 0.33
VOC Emission Concentration (ppmdv, as C_3H_8 at 15 % O_2)	< 0.30	< 0.29	< 0.29	< 0.29
VOC Allowable Emission Concentration (ppmdv, as C_3H_8 at 15 % O_2)	1.2			

Process Data for CT6 - With Duct Burners Firing:

Test Date: 8/20/13				
Run Number	1	2	3	Avg. [1]
Operating Load During Testing (MW)	78.0	80.0	79.9	79.3
Fuel Flow Rate (scf/hr) [1]	490,500	490,500	490,400	490,467
Combined CT & HRSG Heat Input (MMBtu/hr)	506.2	506.2	506.1	506.2
Combined CT & HRSG Rated Heat Input (MMBtu/hr)	510.1			
% of Combined CT & HRSG Permit Rated Heat Input [1]	99.2	99.2	99.2	99.2

H_2SO_4 Mists & SO_2 * Test Results Test Results for CT6 – No Duct Burners Firing:

Test Date: 8/20/13				
Run Number	1	2	3	Avg.
H_2SO_4 Mists Mass Emission Rate (lbs/MMBtu, as H_2SO_4)		0.00044 [1]		
H_2SO_4 Mists Allowable Mass Emission Rate (lbs/MMBtu, as H_2SO_4)		0.0009		
SO_2 Mass Emission Rate (lbs/MMBtu)		0.00028 [1]		
SO_2 Allowable Mass Emission Rate (lbs/MMBtu)		0.0030		

*   data based on fuel sample sulfur analysis for the fuel fired during testing as noted previously

[1]   reviewer calculated or corrected values or averages based upon the reported data

^   the MW load data represents the combined MW contribution during testing from the CT, HRSG, and duct burner (when operated).

cc: AIMS/AKB
      EPA/AKB
      Reading File

ec: V. Trivedi, New Source Review Section, Division of Permits

UGI
DEVELOPMENT CO.

June 14, 2011

CERTIFIED MAIL NO. 7004 2890 0000 4944 9147

Attention: Compliance Testing
Environmental Protection Agency
1650 Arch Street
Philadelphia, PA   19103-2029

RECEIVED
JUN 2 0 2011
3AP20

RE: UGI DEVELOPMENT COMPANY
*   HUNLOCK CREEK ENERGY CENTER*
*   RATA AND COMPLIANCE TESTING*

To Whom It May Concern:

UGI Development Company, Hunlock Creek Energy Center is submitting the Pretest Protocol
for its Combustion Turbines (CT5 and CT6).

The testing is scheduled to take place the week of September 12, 2011. If you should have any
questions, please don't hesitate to contact me at (570) 542-5369 ext. 232 or jsteeber@ugies.com.

Sincerely,

Jeffrey T. Steeber
Environmental, Health & Safety Engineer
Hunlock Creek Energy Center

JTS:chet

360 Old Colony Road, Suite 1
Norton, MA 02766
508-226-6700

PRETEST PROTOCOL

**UGI DEVELOPMENT COMPANY HUNLOCK CREEK ENERGY CENTER
HUNLOCK CREEK, PA
COMPLIANCE EMISSIONS TEST PROGRAM
COMBUSTION TURBINES UNITS 5 & 6 AND AUXILIARY BOILER**

2011

Source Designation:
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Combustion Turbine 5 & 6, Auxiliary Boiler
Hunlock Creek, Pa. 18621

Prepared for:
UGI Development Company
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Hunlock Creek, Pa. 18621

Prepared by:
CEMServices Inc.
360 Old Colony Road, Suite 1
Norton, Massachusetts 02766

Sean MacKay
Technical Director

1/4/2011
Date

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1. INTRODUCTION

The UGI Hunlock Development Company is repowering the Hunlock Creek Energy Center with two (2) new combustion turbine generators (CTG's) in combination with two (2) heat recovery steam generators (HRSG's) with a nominal output of 122 megawatts (MW). In addition, the facility has a 49.9 MMBTU/HR Auxiliary Boiler.

As required by the State of Pennsylvania Department of Environmental Protection (PADEP), and the facility's permit to operate, Hunlock Creek is required to perform compliance testing on each of the two (2) CTG's and the Auxiliary Boiler. This program will consist of testing each turbine (2) at four (4) operating scenarios as follows: Turbine firing gas at normal load, turbine with duct burners firing gas at normal load, turbine firing oil at normal load, turbine with duct burners firing oil at normal load. Each turbine condition will consist of three test runs for CO, NOx, VOC, H2SO4, SO2, NH3 and PM10/2.5. The Auxiliary Boiler testing will consist of firing natural gas for the determination (3, 1 hour tests) of NOx and CO emissions.

UGI Development Company has retained CEMServices of Norton, Massachusetts to perform the Compliance Testing. Table 1-1 below is the test program overview indicating the parameters to be tested, the US EPA test methodologies to be used, and run time duration.

TABLE 1-2
TEST PROGRAM OVERVIEW

CONSTITUENTS	TEST METHODS	TEST RUN LENGTH
Volumetric Flow	EPA Test Methods 1-2	120 Minutes
Oxygen (O2), Carbon Dioxide (CO2)	EPA Test Method 3A	60 Minutes
Moisture	EPA Test Method 4	60 Minutes
PM10/2.5 (total)	EPA Test Method 201A (PM10/2.5 filterable)) EPA Test Method 202 (Condensable PM)	120 Minutes
Nitrogen Oxides (NOx)	EPA Test Method 7E	60 Minutes
Sulfur Dioxide (SO2)/ Sulfuric Acid Mist (H2SO4)	EPA Test Method 8A (aka CTM 013)	60 Minutes
Carbon Monoxide (CO)	EPA Test Method 10	60 Minutes
Ammonia (NH3)	EPA CTM 027	60 Minutes
Total Non-Methane Hydrocarbons (THC)	EPA Test Method 25A/18	60 Minutes

Field testing is expected to commence in the spring/summer of 2011. Sean MacKay, Project Director for this program, will be responsible for all phases of field-testing, data reduction, and report generation. A qualified engineer and technician will assist him. The contact at the facility is Jeff Steeber. Mr. Steeber can be reached at:

Jeff Steeber
Environmental Health & Safety
UGI Development Company
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Hunlock Creek, Pa. 18621
Phone: 570-542-5369 Ext 232
Fax: 570-542-5643
email: jsteeber@ugies.com

2. FACILITY DESCRIPTION

A. General

The Hunlock Creek Energy Center is comprised of two (2) new 50 MW GE LM 6000 PC-Sprint combustion turbine generators (CTG's) in combination with two (2) heat recovery steam generators (HRSG's) with a nominal output of 122 megawatts (MW). Each turbine burns natural gas as the primary fuel and low-sulfur distillate as an optional fuel. The CTG's have water injection to control NOx emission. Each HRSG includes supplemental duct firing and a Selective Catalytic Reduction (SCR) module. A combination of combustion controls and oxidation catalyst is used to control carbon monoxide (CO) emissions. In addition, the facility has a 49.9 MMBTU/HR Auxiliary Boiler.

The following are the emission limits for the CTG's and the Auxiliary Boiler.

TABLE 2-1
HUNLOCK CREEK ENERGY CENTER CTG EMISSION LIMITS

PARAMETER	GT/HRSG FIRING GAS WITHOUT DUCT BURNER		GT/HRSG FIRING GAS WITH DUCT BURNER		GT/HRSG FIRING OIL WITHOUT DUCT BURNER		GT/HRSG FIRING OIL WITH DUCT BURNER	
	ppmdv@ 15% O2	Lb/MMbtu	ppmdv@ 15% O2	Lb/MMbtu	ppmdv@ 15% O2	Lb/MMbtu	ppmdv @ 15% O2	Lb/MMbtu
NOx	2.50		2.90		8.00		8.50	
CO>32°F	4.00		4.00		6.00		6.00	
CO<32°F	10.00		10.00		6.00		6.00	
VOC>32°F	1.20		1.20		1.30		1.30	
VOC<32°F	4.00		4.00		1.30		1.30	
PM10		0.0141		0.0141		0.066		0.066
PM2.5		0.0141		0.0141		0.066		0.066
SO2		0.0030		0.0030		0.0660		0.0660
H2SO4		0.0009		0.0009		0.0200		0.0200
NH$_3$	27.7 Tons/yr 12-month rolling sum							

TABLE 2-2
HUNLOCK CREEK ENERGY CENTER AUXILIARY BOILER EMISSION LIMITS

PARAMETER	LIMIT FIRING GAS (ppmdv @ 3% O2)
NOx	30
CO	300

2. FACILITY DESCRIPTION (continued)

B. Test Location

The test platform for the CTG's are located at the 107 foot level. Four EPA test ports are located at the level for stack testing. A sketch of the sampling location is presented in Figure 2-1.

10 ' diameter

Top of stack 192 feet
above grade

EPA test ports (4) 112.8'

Damper 61'

SCR

Figure 2-1
Hunlock Creek Energy Center
Sample Port Locations
Units 5 & 6

Figure not drawn to scale

Stack Height Above Grade - 192 feet
Stack Inside Diameter at Test Port – 10.0 ft

Disturbance Distances
  1. Above Grade 192.5feet
  2. Above Last Disturbance (damper to test ports)
    A. Feet – 51.8 feet
    B. Stack Diameters – 5.2
  3. Prior to Stack Exit (test ports to stack exit)
    A. Feet – 79.2 feet
    B. Stack Diameters – 7.9

3. REFERENCE METHOD TEST PROCEDURES

A. Velocity Traverse - EPA Test Method 1

Method 1 procedures delineate velocity traverses for stationary sources. As based upon the dimensions of the stacks and EPA Method 1 criteria for particulate traverses, a total of twenty (20) traverse points, would be required, however Method 201A specifies a maximum of 12 points, three (3) points per each of the four (4) ports, to be used for particulate determinations. Velocity determinations for other testing (H2SO4, NH3) will be performed using twenty (20) traverse points (five per port). The probes will be marked according to the measurements in Table 3-1, and 3-2.

TABLE 3-1
TRAVERSE POINT LOCATIONS FOR PM10/2.5 TESTING

Traverse Point	Distance (% Diameter)	Distance from Wall (inches)
1	4.4	5.3
2	14.6	17.5
3	29.6	35.5

TABLE 3-2
TRAVERSE POINT LOCATIONS FOR H2SO4 AND NH3 TESTING

Traverse Point	Distance (% Diameter)	Distance from Wall (inches)
1	2.6	3.1
2	8.2	9.8
3	14.6	17.5
4	22.6	27.1
5	34.2	41.0

The pitots will be connected to a manometer using 1/8 inch ID Tygon tubing. These connections will be checked for leaks before they are initially used and at the conclusion of each run.

B. Flow Rate - EPA Test Method 2

Method 2 will be used for the determination of stack gas velocity and volumetric flow rate. Prior to testing a cyclonic flow check will be conducted to verify the absence of cyclonic flow. Before the velocity traverse is started, a leak check will be conducted on the pitots, and the manometer will be leveled. The velocity head and stack gas temperature will be recorded for each of the required sampling points. Simultaneous gas density (Method 3A) and stack gas moisture content (Method 4) testing will be conducted during every test run.

3. REFERENCE METHOD TEST PROCEDURES (continued)

C. Ammonia / Moisture Content - EPA CTM 027

Conditional Test Method 027 is used for the determination of moisture and Ammonia content in stack gas. This method consists of extracting a known volume of gas sample and quantifying the removed Ammonia portion of this sample.

Before each test run the sampling train will be prepared. First, an in-stack glass filter holder will be loaded with a glass fiber filter and glass sampling nozzle. This nozzle will be sized for isokinetic sampling. This filter holder will then be attached to a stainless steel sample probe with a glass liner and a Teflon lined stainless steel union. The probe will then be connected to the impingers using a Teflon jumper. The impingers used to remove condensate and Ammonia from the gas will be prepared as follows: A total of four impingers will be loaded according to the method. The first three impingers will be loaded with 100 ml 0.1 N H2SO4 and the fourth will be loaded with silica gel. The sampling train will be assembled and the sampling probe heated. The train will be checked for leaks by plugging the sample inlet and challenging the train with a vacuum of 15 inches of Hg. All leak rates will be below 0.02 CFM. The initial meter volume will be recorded and the probe will be positioned at the first of the sixteen required traverse points. Sampling will be conducted isokinetically for the entire sixty (60) minute run at the points listed in Table 3-2.

At the completion of each test run the final meter volume will be recorded and another leak check will be conducted. The in-stack filter and nozzle will be removed and the probe and jumper will be rinsed and recovered on the stack. The impingers will then be recovered and their final volumes recorded. The final volumes will be used to calculate the moisture content of the stack gas. All rinses will be added to the catch into one sample bottle for each test run. Samples will be sent to Enthalpy Analytical of Raleigh, North Carolina for analysis by Ion Chromatography.

D. PM10/2.5 / CPM – EPA Method 201A / 202

This method is used for the determination of PM10 and condensable particulate emissions from stationary sources. Particulate matter is drawn isokinetically from the source and collected through a cyclone onto a glass fiber filter. Particulate that makes it to the filter is considered the PM10 portion of the total sample. Sample rates and dwell times will be calculated using PM10 / PM2.5 Software for Windows obtained from Apex Instruments.

The condensable particulate matter (CPM) is collected in a Method 23 type condenser, dry impingers and a CPM filter between the second and third impingers after the filterable PM has been collected. Before each test run the impingers used to remove condensate from the gas will be prepared. A total of four impingers will be used according to the method. Two cyclone sizing devices are placed in series (PM2.5 first then PM10) onto an in stack filter holder containing a desiccated tared filter. Prior the start of each run a leak check will be performed from the end of the nozzle at a vacuum of 15 inches of mercury.

The run will then be initiated and isokinetic sampling at a constant rate will take place. The entire stack will be traversed according to the sample points specified in Method 201A. Dwell time will be established for each point during the two-hour test run. At the conclusion of the test, the sizing devices will be removed and a post leak check will be conducted at the highest vacuum obtained during the run. If no water is collected before the CPM filter then the purge may be skipped. Otherwise the impinger train will be purged with zero-grade nitrogen gas for 1 hour following the leak check as described in

3. REFERENCE METHOD TEST PROCEDURES (continued)

Section 8.5.3 of U.S. EPA Method 202, to purge dissolved SO_2 gas from the impinger solutions. The purge will be started within 10 minutes of completing the run, typically at the recovery lab. The nitrogen purge line will be connected to a clean particle and activated carbon filters attached to the impinger train inlet to minimize potential particle or vapor contamination.

The sample train will be then moved to the cleanup site where it will be recovered in strict accordance with Method 201A Sample Recovery Procedures as follows:

Container #1. The filter will be carefully removed from the filter holder and placed in it's identified petri dish container.

Container #2 and #3. Taking care to see that dust on the outside of the cyclone heads or other exterior surfaces does not get into the sample, particulate matter from the heads (PM2.5 & PM10) will be quantitatively recovered by rinsing these components with acetone into a separate glass or Nalgene container. The inside of each component will be brushed and rinsed until the acetone rinse shows no visible particles, after which a final rinse of the inside surface will be performed. All gravimetric analysis will be conducted in accordance with Test Method 201A.

Container #4 (CPM container #1): The contents of the dropout and backup impingers prior to the CPM filter will be quantitatively recovered into this container. All sampling train components including the back half of the filterable PM filter holder, the probe extension, condenser, each impinger and the connecting glassware, and the front half of the CPM filter housing will be rinsed twice with water. This will be added to CPM Container #1.

Container #5 (CPM container #2, organic rinse): Following the water rinse, all sampling train components including the back half of the filterable PM filter holder, the probe extension, condenser, each impinger and the connecting glassware, and the front half of the CPM filter housing will be rinsed with acetone and placed in CPM container #2. This will be followed by two rinses of hexane into the same container (CPM #2).

Container #6 (CPM container #3 filter).
Container #7 (CPM container #4 cold impinger water).
Container #8 (CPM container #5 sigel)
Container #9 (CPM container #6 acetone field blank)
Container #10 (CPM container #7 water field blank)
Container #11 (CPM container #8 hexane field blank)
Container #12 (CPM container #9 field train proof blank inorganic)
Container #13 (CPM container #10 field train proof blank inorganic)

Enthalpy Analytical, a New Jersey certified laboratory of Durham, NC will perform the analysis in accordance with Method 202.

3. REFERENCE METHOD TEST PROCEDURES (continued)

E. Nitrogen Oxides and CEMS Calibration Procedures - EPA Test Method 7E

Method 7E is used for the determination of Nitrogen Oxides emissions from stationary sources using instrumental analyzer procedures. In addition, all calibration procedures and requirements for the other instrumentation methods used, Methods 3A, 6C, and 10 are specified in this method.

span or within 0.5 PPM, when compared to the analyzer calibration error check conducted Before any testing is conducted, the calibration span of all test analyzers will be set up so that expected source emissions will be at least twenty (20) percent of this span and will not exceed this span. Once this span is determined, calibration gases will be chosen within this span. Only gases prepared according to EPA Protocol G1/G2 will be used. Certificates of analysis for all gases will be provided on-site at the time of testing. Analyzer calibration error checks will then be conducted by challenging each analyzer with a zero, mid, and high gas. The actual value of the high gas used will be the calibration span of each analyzer. Analyzer responses to these gases will be within two (2) percent of the instrument's span or within 0.5 PPM of the gas value. Before and after each test run a sampling system bias check will be conducted on each monitor. This check will consist of introducing the calibration gases at the sampling probe thus allowing the gases to travel through the entire sampling system including any filters. The analyzer responses to this check will then be recorded by the data acquisition system. All system bias check responses will be within five (5) percent of the instruments initially.

The sampling system bias check conducted prior to each test run will be compared to the sampling system bias check conducted at the completion of that same run. Differences between the two bias checks constitute the upscale and zero calibration drifts. All calculated calibration drifts will be below three (3) percent of the span of the analyzer or within 0.5 PPM. Once the initial system bias check is conducted the system will be put into the sample mode and data acquisition will be initiated. The probe will be positioned at the first of the required traverse points.

To ensure that the NH3 in the stack gas (if applicable) will not be converted to NO, CEMServices will utilize a Model 300 Molybdenum converter. The Molybdenum converter is used to convert NOx to NO at a lower temperature (approx. 350 °C) specific to NOx, thus eliminating the conversion of NH3.

A Thermo Environmental Model 42 NOx/NO2/NO analyzer will be used to continuously measure the concentration of NOx in the effluent gas. The analytical technique of the analyzer is chemiluminescence. In the determination of NOx, the sample is routed through a molybdenum converter where the NO2 is disassociated to form NO. The sample is then passed through a reaction chamber where the NO is quantitatively converted to NO2 by gas phase oxidation with molecular ozone produced within the analyzer. In this reaction, the NO2 molecules are elevated to an electronically excited state, and then immediately reverted to a non-excited ground state. This reversion is accompanied by the emission of photons, which impinge on a photomultiplier detector and generate a low level DC current. The current is then amplified and used to drive a front panel LED display and data recorder. The NOx concentration measured by the instrument includes the contributions of both the NO in the effluent and the NO resulting from the dissociation of NO2. The efficiency of this converter will be checked prior to testing using the procedure specified in Section 8.2.4.1 of this Method.

3. REFERENCE METHOD TEST PROCEDURES (continued)

A STRATA data shuttle will document voltage output from each monitor. This instrument sends all signals via a RS-232 cable to a computer for data archiving. Data points will be logged every two (2) seconds during each test run. At the test run completion, data will be transferred to a spreadsheet for determination of the raw run average. This data will be included in the final report. Results from the initial and final system bias checks will be used to adjust the raw run average to correct it for any deviations due to the system bias.

F. Oxygen and Carbon Dioxide - EPA Test Method 3A

Method 3A is used for the determination of Oxygen and Carbon Dioxide emissions from stationary sources using instrumental analyzer procedures. All calibration procedures and requirements for this instrumentation method are identical to those found in EPA Test Method 7E.

O_2 content in the effluent will be determined by a California monitor which utilizes a micro-fuel cell that consumes O_2 from the atmosphere surrounding the measurement probe. The consumption of O_2 generates a proportional electrical current. This current is then amplified and provides a signal output of 0-1 V DC which corresponds to a full scale range of 0-25 % O_2.

A California Analytical non-dispersive infrared analyzer is used to continuously measure the CO_2 concentration in the effluent. The theory of operation for this analyzer is based on the principle that CO_2 has a unique absorption line spectrum in the infrared region. The instrument consists of an infrared light source, a chopper, a measurement cell, and a detector. The infrared light beam emitted by the source passes through the measuring cell, which is filled with a continuously flowing gas sample. The light beam is partially absorbed or attenuated by the gas species of interest in this cell before reaching the front chamber of the detector.

Both the front and rear chambers of the sealed detector are filled with a reference gas. The difference in the amount of light absorbed between the front and rear chambers are dependent of the concentration of the gas species of interest within the sample measurement cell. A pressure differential is thus created between the two chambers. This pressure difference is then observed as gas flow by the micro-flow sensor located in a channel connecting the two chambers. The resulting AC signal from the micro-flow sensor is rectified, amplified, and linearized into a DC voltage signal for output. An interference response check will be conducted on the O_2 and CO_2 analyzers prior to testing.

G. Carbon Monoxide - EPA Test Method 10

Method 10 is used for the determination of Carbon Monoxide emissions from stationary sources using instrumental analyzer procedures. All calibration procedures and requirements for this instrumentation method are identical to those found in EPA Test Method 7E.

A Thermo Environmental Model 48 Gas Filter Correlation (GFC) analyzer is used to continuously sample the CO concentrations in the gas stream. GFC spectroscopy is based on the comparison of the infrared (IR) absorption spectrum of the measured gas to that of other gases in the sample being analyzed. This technique is implemented by using a high concentration sample of the measured gas (i.e. CO) as a filter for the infrared radiation transmitted through the analyzer. Radiation from an IR source is

3. REFERENCE METHOD TEST PROCEDURES (continued)

chopped and passed through a gas filter alternating between CO and N2 due to rotation of the filter wheel. The radiation then passes through an interference filter and on to an absorption cell.

The IR radiation exits the sample cell and falls on to an IR detector. The CO gas filter produces a reference beam which cannot be further attenuated by CO in the sample cell. The N2 side of the filter wheel is transparent to the IR radiation and thus produces a measure beam which is partially absorbed by CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with is amplified and related to the concentration of CO in the sample cell. Other gases, which absorb the reference and measure beams equally, do not cause modulation of the detector signal leaving the GFC responding specifically to CO.

H. Volatile Organic Compounds (VOC) Total – EPA Test Method 25A

Method 25A is used for the measurement of volatile organic compounds (VOC) concentrations using flame ionization detection (FID). A Vig Industries FID is the analyzer that will be used for compliance determinations of VOC's. For this method a gas sample is continuously extracted from the source through a heated (approx. 250° F) Teflon sample line to the FID. During each Method 25A test run an integrated bag sample will be taken from the bypass of the FID. This sample will be analyzed for Methane using EPA Method 18 within 48 hours if the total VOC is over the emission limit.

During FID sampling, CH molecules in the sample are introduced in the burner socket through the burner tip and into a hydrogen flame. The thermal energy (caused by combustion of hydrogen) cracks the CH molecules into C and H atoms. In the hot zone the C atoms loose a certain number of electrons and now become C ions with a positive charge. The negative electrical field created by a negative charge imposed on the collector (which supplies an excess of negative electrons) influences the positive charged C ions which are drifting towards the collector and absorb a number of electrons thus neutralizing the positive C ions.

This neutralization causes a change in the current between the electrodes and is directed through a high impedance amplifier which is connected to a meter type readout. The neutralized C atoms combine with the O_2 (from the combustion source) to form CO_2. The hydrogen introduced to form the flame combusts into water vapor. Prior to testing the sample train will be assembled by connecting one end of the probe to the sample line and the other to the FID. The train will then be leak checked.

The FID will be calibrated and the responses to a zero and three other methane calibration gases within the range of the instrument are recorded onto a data sheet. A sampling system bias check is required and will be conducted by introducing the bias check standard directly into the flame ionization analyzer (FIA) and then through the entire sampling system, excluding the probe. If the results agree within 5%, the bias check is acceptable; otherwise the test data (since the last valid bias check) is invalid. Once sampling is initiated, the signal from the FID is sent to the data logger and computer. Data will be archived at 2-second intervals during each test run. If necessary, an ambient sample for VOC may be collected for determining background levels.

3. REFERENCE METHOD TEST PROCEDURES (continued)

I. Sulfur Dioxide and Sulfuric Acid Mist – EPA Method 8A (CTM 013)

CTM 013 (aka Method 8A) was developed as an alternative to Method 8 and is used for the determination of Sulfuric Acid Mist and Sulfur Dioxide and in stationary sources. Method 8 is subject to interferences from sulfates which may be present is the particulate matter and sulfur dioxide. The alternative method uses an in-line quartz filter to remove particulate in the gas stream prior to capturing the sulfur trioxide. The use of a controlled condensation technique eliminates the potential for interference from sulfur dioxide.

The basic principle is a gas sample is extracted from the sampling point in the stack. The sulfuric acid vapor or mist (including sulfur trioxide) and the sulfur dioxide are separated, and both fractions are measured separately by the barium-thorin titration method or by ion chromatography (IC).

Before each test run the impingers and condenser used to remove condensate from the gas will be prepared. A total of four impingers will be loaded according to the method (Greenburg Smith, modified Greenburg Smith, Greenburg Smith, and modified Greenburg Smith). 100 ml of 3% H_2O_2 will be loaded into the first two impingers. The third impinge will be loaded with 100 ml of DIUF and the fourth with 200g of silica gel. The impingers will be preceded by a heated glass probe (350 deg F), a heated quart filter (500 deg F) and a modified Grahm condenser filled with water and maintained between 167 deg. F and 187 deg. F. Prior the start of each run a leak check will be performed from the end of the nozzle at a vacuum of 15 inches of mercury.

Sampling will then take place at a constant rate of about 10 L/min for at least 30 minutes. At the conclusion of the run another leak check will be performed at the highest vacuum recorded during the run. The probe will then be disconnected, the ice bath drained and the impingers will be purged with clean ambient air for 15 minutes at the average flow rate used during sampling. After purging, the probe, filter holder and condenser will be rinsed separately three times each with DIUF. The condenser rinse will be collected in Container 1. Impingers 1 and 2 will be measured for volume and then transferred to Container 2. These containers will then be analyzed by Enthalpy Analytical by either titration or IC.

J. CEM Stratification Check

Before any reference method test data is taken, a CEM stratification check will be conducted to ensure that there is no stratification at the stack test location. Stratification is defined as a difference in excess of 10 percent between the average concentration of the stack and the concentration at any other point. To ensure stratification does not exist, CEMServices will conduct a 16-point CEM traverse using the points to be used in the flow traverse as specified in Method 1. Each point will be sampled for two (2) minutes.

The facility-operating load will be used as a reference point to ensure process changes haven't occurred during the time needed to conduct the traverse. Once the traverse is completed, each point will be checked to see if it is within 10 percent of the average of all the points. Traverse points will be switched to 0.4, 1.2, and 2.0 meters from the stack wall for RATA testing if no stratification is found.

4. REFERENCE METHOD TEST EQUIPMENT

A. PM 2.5 / PM10 / H2SO4/ NH3 Sampling Train

Testing described in Section 3, will be conducted using a Modified Method 5 sampling train. The train, manufactured by Nutech, consists of the following components:

Meter Box - The meter box used in this program will be the Nutech Model 2010 - Isokinetic Stack Sampler. This box consists of a leak-free sample pump, a dry gas meter, a vacuum gauge, and temperature readout. Thermocouples are mounted on the inlet and outlet of the dry gas meter to provide meter temperatures during testing.

Umbilical - The umbilical to be used in this program consists of a sample line, pitot lines, and thermocouple lines. These lines transport sample from the impingers to the meter box, indicate pressure difference at the pitots to the meter box, and carry temperature signals from the stack to the temperature readout in the meter box.

Condenser System - This system consists of four glass impingers placed in series and in an ice bath. When prepared for a test run, the first three impingers will be loaded with the appropriate solutions and the fourth will be loaded with a 200 g of silica gel.

PM2.5/10 Cyclones and In-Stack Filter Holder - The holder is made of stainless steel and contains two cyclones for PM separation and a tube that leads to a glass fiber filter housed in a stainless steel holder.

Probe - The probe assembly consists of a set of "S" type pitots, a stack thermocouple, and a stainless steel sheath with a heated quartz glass liner.

Nozzle - The nozzles are a stainless steel tapered cylone design available in a range of sizes for isokinetic sampling.

B. Mobile CEM Laboratory

All reference test methods described in Section 3 will be conducted using the CEMServices mobile CEM laboratory. This laboratory consists of all analyzers and support equipment necessary to conduct the CEM sampling during this test program. The following is a description of each item that makes up the entire system:

Sample Probe - A seven foot heated stainless steel probe will be used for this test program. The probe is manufactured by Labyrinth Systems and has a filter at the end of it to remove particulate matter. The other end contains a heated three-way assembly. An extension will be added if the entire stack needs to be sampled due to stratification.

Particulate Filter - This in-stack filter is a Labyrinth Systems 5 micron sintered stainless steel filter.

Calibration Valve Assembly - The calibration valve assembly allows the CEM operator to chose between sample and system calibration. A three-way assembly is housed inside a heated (250 °F), water resistant box at the end of the probe. This assembly will be capable of blocking and introducing calibration gas into the system without pressurizing it.

Heated Sample Line - This heated jumper is ten (10) feet long and transports the gas sample to the moisture removal system. The jumper is temperature self regulating and will maintain a temperature of 250 degrees F.

4. REFERENCE METHOD TEST EQUIPMENT (continued)

Moisture Removal System - This system continuously removes moisture from the sample gas while maintaining minimal contact between the condensate and the sample gas. CEMServices uses an electric condenser consisting of three (3) stainless steel heat exchangers that are continuously drained of condensate by two (2) peristaltic pumps. The inlet to the system is connected to the heated sample line and the outlet is connected to the sample transport line.

Sample Transport Line - 3/8-inch OD Teflon tubing will be used to transport the gas sample to the mobile laboratory. Approximately one hundred (100) feet of tubing will be used.

Sample Pump - A dual headed diaphragm pump will be used to transport the gas sample through the system to the sample gas manifold. Air Dimension manufactures this pump and all parts coming into contact with the gas stream are either Teflon or stainless steel.

Sample Gas Manifold - This manifold consists of a series of valves and adjustable rotameters capable of setting and maintaining the desired backpressure and flow rate to the analyzers during both sampling and calibration.

Sample Gas Analyzers - CEMServices will use the following analyzers to complete this test program:

TABLE 4-1
REFERENCE METHOD ANALYZERS

Gas	Manufacturer	Model	Range
O2	California Analytical	100	0-25 %
CO2	California Analytical	100	0-20 %
NOx	Thermo Electron	42	0-10 PPM
CO	Thermo Electron	48	0-20 PPM
VOC	Vig Industries	55	0-10 PPM as Methane

Data Recorder - All voltage outputs from the analyzer will be sent to a Strawberry Tree data shuttle. This data shuttle, hooked up in series with an IBM compatible computer and Hewlett Packard printer collects point data thirty times per minute and prints out one-minute averages for each run. All raw calibration and run data will be saved to a file and printed out.

C. Calibration Gases

All calibration gases used for this test program will be prepared according to EPA Protocol #1. As per EPA Test Method 7E for all O2, CO2, and NOx testing, all mid calibration gas values will be between 40-60 % of the analytical range of the analyzer, and all high calibration gases will be between 80-100 %. The zero calibrations (including calibration error check and system bias check) for all analyzers will be conducted using pre-purified grade Nitrogen. As per Method 25A the low gas value will be 25-35% of span, the mid gas value will be between 45-55% of span and the high gas value will be between 80-90% of span.

4. REFERENCE METHOD TEST EQUIPMENT (continued)

Below is a sample list of the gases to be used in this test program:

TABLE 4-2
REFERENCE METHOD CALIBRATION GASES

Gas/Range	Allowable Values	Cal Point
O2 0-25 %	10-15 20-25	Mid High
CO2 0-20 %	8-12 16-20	Mid High
NOx 0-10 PPM	4-6 8-10	Mid High
CO 0-20 PPM	8-12 16-20	Mid High
THC 0-10 PPM	2.5-3.5 4.5-5.5 8-9	Low Mid High

5. QUALITY CONTROL PROCEDURES

A. General

Throughout all phases of this test program strict attention will be given to all phases of testing to provide the highest quality of results possible.

All of CEMServices test equipment is of the highest quality available and undergoes routine maintenance to ensure top operating condition. This includes meter boxes, thermocouples, barometers, pitot tubes and sampling nozzles.

Meter boxes are calibrated over a full range of flow rates against certified orifices every six months. Thermocouples are calibrated as specified in the EPA Handbook against a NBS traceable mercury in glass thermometer. Pitot tubes are visually inspected for conformance to the dimensions specified in EPA Method 2.

Trained personnel will conduct sampling with extensive experience in CEM sampling. All analyzers are tested for interference of other gas compounds at least once every six months. In addition, a converter efficiency check is performed on the NOx analyzer to ensure the proper conversion of NO2 to NO.

All sampling and analysis will be conducted in strict accordance with EPA test procedures (where available). The quality control procedures found in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems will be adhered to as well.

Analyzer calibrations will be performed at the beginning of each test day. System calibrations will be performed before and after each test run through the entire sampling system.

All calculations will be conducted in strict accordance with the equations found in the individual Methods. Calculations will be conducted on a computer and a person other than the original calculator will ensure that it is correct and will check the input data.

The entire staff of CEMServices is thoroughly familiar with all test methods used in this program and has extensive experience in source emission monitoring.

DEFINITION OF ABBREVIATIONS

ACFM	Flowrate reported in actual cubic feet per minute.
An	Area of the nozzle, cross-sectional, in square feet.
As	Area of the stack in square feet.
BWO	Water vapor in gas stream, proportional by volume.
CC	Percent error confidence coefficient (one tailed).
Cd	Conversion calibration for concentration (PPMdv to lbs/SCF)
Cgas	Final emissions data reported by CEMS, adjusted for calibration drift. Reported as ppm dry, proportional by volume.
Cm	Average CEM response to initial and final span gas system calibration.
Cma	Concentration of the calibration gases.
Co	Average CEM response to initial and final zero gas system calibration.
Craw	Raw emissions data reported by the CEMS, uncorrected for calibration drift.
Cwet	Final emissions data reported by CEMS, adjusted for calibration drift and water vapor. Reported as ppm wet, proportional by volume.
% CO	Percent of carbon monoxide in the flue gas.
% CO_2	Percent of carbon dioxide in the flue gas.
Cp	Pitot tube coefficient.
Cs	The concentration in the stack in pounds per standard cubic foot.
Cs'	The concentration in the stack in grains per standard cubic foot.
Cs' @ 12%	The concentration in the stack in grains per dry standard cubic feet corrected to 12% CO_2.
DELTA H	The pressure differential across orifice meter, reported in inches of H_2O.
DELTA H(ABS)	The pressure differential across orifice meter, absolute conditions in inches of mercury.
Dn (IN)	Diameter of the nozzle in inches.
DGM IN	Temperature of the dry gas meter inlet, reported in degrees Fahrenheit.
DGM OUT	Temperature of the dry gas meter outlet, reported in degrees Fahrenheit.
Ds (FT)	Diameter of the stack in feet.
DSCFH	Dry standard cubic feet per hour.
DSCFM	Dry standard cubic feet per minute.
DSCMH	Dry standard cubic meters per hour.
E	Emission rate in pounds per million Btu using F Factor of fuel burned.
END METER	The dry gas meter reading at the end of the test.
F FACTOR	The theoretical amount of air in dry standard cubic feet (DSCF) needed to combust a million Btu's worth of fuel.
GR/BHP-HR	Grams per brake horsepower hour.
IMP(FIN)	Final volume of absorbing solution in impinger.
IMP(INT)	Initial volume of absorbing solution in impinger.
INT METER	The dry gas meter reading at the beginning of the test.
% ISO	Variation of sampling from isokinetic conditions.
LB/HR	Pounds per hour.
LB/MMBTU	Pounds per million British Thermal Unit.
LB/SCF	Pounds per standard cubic foot.
Md (DRY)	The dry molecular weight of the flue gas in pounds per pound mole.
MI	Volume in milliliters.
Mg/M3	Milligrams per cubic meter.
Mn	Total particulate found in sample minus the acetone residue (blank). Reported in milligrams.
Ms (WET)	Wet or actual molecular weight of the flue gas in pounds per pound mole.
MW	Molecular weight
% N2	The percent of nitrogen in the flue gas.
NO. PTS	Number of traverse points.
% O2	% oxygen in the flue gas.
P BAR	Barometric pressure at test location.
PIT COEFF	Pitot tube coefficient (S Type=.84, standard=.99).
PPM	Parts per million.

DEFINITION OF ABBREVIATIONS

PPMdv	Parts per million - dry volume.
PPMwv	Parts per million - wet volume.
P STK	Static pressure of the stack in inches of water.
PMR	The pollutant mass rate in pounds per hour.
PS (ABS)	Absolute stack pressure in inches of mercury.
Pstd	Standard absolute pressure, (29.92 in. Hg).
Qs	The volumetric flow rate of the flue gas in dry standard cubic feet per hour.
RA	Relative accuracy.
RATA	Relative accuracy test audit.
RM	Reference Method.
Sd	Emission standard (allowable emission rate).
SQ ROOT	The square root of each velocity head measurement (Delta P).
SQRT DELTA P	The average of the square roots of the measured pressure drops.
Stack Temp	The temperature of the stack in degrees (°F) Fahrenheit.
TM (°F)	Average temperature of the dry gas meter in degrees Fahrenheit.
TM (°R)	Average temperature of the dry gas meter in degrees Rankine.
TS (°R)	The temperature of the stack in degrees Rankine.
VEL HEAD	The pressure drop measured across the pitot tubes.
VI (TOT)	The amount of water collected in the impingers in milliliters.
VM (CF)	The volume sampled through the dry gas meter in cubic feet.
VM STD	Volume sampled through the dry gas meter corrected to standard conditions.
VOC	Volatile organic compounds
VS	Velocity of the stack gas in feet per second.
VW STD	The amount of moisture collected, corrected to standard conditions.
Y	Dry gas meter calibration factor.

VELOCITY TRAVERSE DATA AND PM2.5/10 EMISSION CALCULATIONS

FACILITY:
UNIT   :
DATE   :

RUN ID# :
START TIME:
END TIME:

	TRAV PT	DELTA P	SQ ROOT	DELTA H	DGM IN	DGM OUT	STACK TEMP
Ds (FT)							
As (SQFT)							
Y =							
PIT COEFF							
Dn (IN)							
An (SQFT)							
IMP-1 (INT)							
IMP-2 (INT)							
IMP-3 (INT)							
IMP-4 (INT)							
IMP-1 (FIN)							
IMP-2 (FIN)							
IMP-3 (FIN)							
IMP-4 (FIN)							
% CO2 (OUT)							
% O2 (OUT)							
% CO (OUT)							
% N2 (OUT)							
F-FACTOR							

P BAR
PSTK

FINAL METER
INT METER
MID LEAK CK
VM (CF)
RUN TIME

AVG:
TS ('R) =
TM ('F) =
TM ('R) =

DELTA H (ABS) =
PS (ABS)   =
VI (TOT)   =

SAMPLE	FILTER	BEAKER
PARTICULATE		
WEIGHT (mg)		

TOTAL SAMPLE GAIN LESS ACETONE RESIDUE (Mn)   =   mg

$VM\ STD$ = $17.64\ (VM)\ (Y)\ (DELTA\ H\ ABS)\ /\ (TM)$ =   DSCF

$VW\ STD$ =   =   CF

BWO =   =

$Md\ (DRY)$ = $.44(\%CO2)+.32(\%O2)+.28(\%CO)+.28(\%N2)$ =   LBS/MOLE

$Ms\ (WET)$ =   =   LBS/MOLE

G =   =

VS =   =   FPS

H =   =

J = $(DELTA\ H\ ABS)\ (VM)\ (Y)\ /\ (TM)$ =

K =   =

$\%\ ISO$ = $((TS)(K)(1.667))/\ ((TIME)(VS)(PS)(AN))$ =   %

Qs = $3600(1-BWO)(VS)(AS)(17.64)(PS)/(TS)$ =   DSCFH

CS = $(2.205x10-6)\ (MN)\ /\ (VM\ STD)$ =   LBS/SCF

CS' = $.0154\ (MN)\ /\ (VM\ STD)$ =   GRAINS/SCF

$CS'@7\%O2$ = $CS'\ *\ (20.9-7)\ /\ (20.9\ -\ O2)$ =   GRAINS/SCF

$CS'@12\%CO2$= $CS'\ *\ (12\ /\ \%\ CO2)$ =   GRAINS/SCF

PMR = $CS\ X\ Qs$ =   LBS/HR

E = $CS\ x\ FUEL\ FACTOR\ X(20.9/(20.9-\%O2))$ =   LBS/MMBTU

CONDENSIBLE PARTICULATE EMISSION CALCULATION SHEET

FACILITY:
UNIT   :
DATE   :

	TRAV PT	DELTA P	SQ ROOT	DELTA H	DGM IN	DGM OUT	STACK TEMP

RUN ID# :
START TIME:
END TIME:

Ds (FT)
As (SQFT)
Y =
PIT COEFF
Dn (IN)
An (SQFT)
IMP-1 (INT)
IMP-2 (INT)
IMP-3 (INT)
IMP-4 (INT)
IMP-1 (FIN)
IMP-2 (FIN)
IMP-3 (FIN)
IMP-4 (FIN)
% CO2 (OUT)
% O2 (OUT)
% CO (OUT)
% N2 (OUT)
F-FACTOR

P BAR
PSTK

FINAL METER
INT METER
MID LEAK CK
VM (CF)
RUN TIME

AVG:
TS ('R)=   DELTA H (ABS) =
TM ('F)=   PS (ABS)   =
TM ('R)=   VI (TOT)   =

SAMPLE   ORGANIC   INORGANIC
CATCH (LESS
BLANK (mg)   mg

MN = Total Condensible Particulate   =   mg
VM STD   = 17.64 (VM)(Y)(DELTA H ABS) / (TM)   =   DSCF
VW STD   =   =   CF
BWO   =   (VW STD)/(VW STD)+(VM STD)   =
Md (DRY) = $.44$(%CO2)+$.32$(%O2)+$.28$(%CO)+$.28$(%N2) =   LBS/MOLE
Ms (WET) =   Md(1-BWO)+18(BWO)   =   LBS/MOLE
G   =   SQRT (TS / PS / MS)   =
VS   = 85.49(CP)(G)(SQRT DELTA P)   =   FPS
H   = 0.002669 (VI TOT)   =
J   =   (DELTA H ABS)(VM)(Y) / (TM)   =
K   =   (H) + (J)   =
% ISO   =   ((TS)(K)(1.667))/ ((TIME)(VS)(PS)(AN))   =   %

Qs   =   3600(1-BWO)(VS)(AS)(17.64)(PS)/(TS)   =   DSCFH
CS   =   (2.205x10-6)(MN) / (VM STD)   =   LBS/SCF
CS'   = $.0154$ (MN) / (VM STD)   =   GRAINS/SCF
CS'@7%O2 =   CS' * (20.9-7) / (20.9 - O2)   =   GRAINS/SCF
CS'@12%CO2=   CS' * (12 / % CO2)   =   GRAINS/SCF
PMR   =   CS X Qs   =   LBS/HR
E   =   CS x FUEL FACTOR X(20.9/(20.9-%O2))   =

NOx EMISSION RATE CALCULATION

FACILTY: RUN ID#:
UNIT: START:
DATE: END:

Cgas PPMdv =   Cgas % CO2   =

PPMV @15% O2 =   Cgas % O2   =

M.W. NO2   =   FUEL FACTOR(Fd) =

BWO %   =   Qs DSCFH   =

$Cd = Cgas \times 1.194 \ E-7$ =   LBS/SCF

$E = Cd \times FUEL\ FACTOR \times (20.9/20.9-\%O2)$ =   LBS/MMBTU

$PMR = CD \times QS\ DSCFH$ =   LBS/HR

CO EMISSION RATE CALCULATION

FACILTY: RUN ID#:
UNIT: START:
DATE: END:

Cgas PPMdv =   Cgas % CO2   =

PPMV @15% O2 =   Cgas % O2   =

M.W. CO   =   FUEL FACTOR(Fd) =

BWO %   =   Qs DSCFH   =

$Cd = Cgas \times (M.W./385.6) / 1,000,000$ =   LBS/SCF

$E = Cd \times FUEL\ FACTOR \times (20.9/20.9- \%O2)$ =   LBS/MMBTU

$PMR = CD \times QS\ DSCFH$ =   LBS/HR

AMMONIA EMISSIONS CALCULATION SHEET

FACILITY: RUN ID#:
UNIT   :   START:
DATE   :   END:

                                        VOLUME
SAMPLE ANALYTE SUMMARY REPORT   (ml)

IMP 1,2,3,RINSE - MICROGRAMS PER MILLITER =   ug/ml
DILUTION FACTOR =

IMP 1,2,3,RINSE - MICROGRAMS PER SAMPLE   =   ug

TOTAL (ug) - MICROGRAMS PER SAMPLE   =   ug

MOLECULAR WEIGHT OF AMMONIA (NH3)   =

                                          VOLUME
BLANK ANALYTE SUMMARY REPORT   (ml)

BLANK - MICROGRAMS PER MILLITER   =   ug/ml
TOTAL BLANK - MICROGRAMS PER SAMPLE   =   ug

VM STD = 17.64 * (VM)*Y*DELTA H ABS) / (TM) =   DSCF

FUEL FACTOR(Fd)=

GAS INPUT =   HSCFH

Btu CONTENT =   Btu / HSCF

$$CS = (2.205 \times 10^{-9}) (ug) / (VM\ STD) = \qquad LBS/DSCF$$

$$CS' = 0.0000154 (ug) / (VM\ STD) = \qquad GRAINS/DSCF$$

$$PPMdv = \frac{CS * 1000000}{(MW\ NH3) / 385.6} = \qquad PPM$$

$$PPM\ @\ 15\%\ O2 = PPM * (20.9\text{-}15/20.9\text{-}\%O2) = \qquad PPM\ @\ 15\%\ O2$$

$$E=Cd \times FUEL\ FACTOR \times (20.9/20.9\text{-}\%O2) = \qquad LBS/MMBTU$$

$$PMR = LBS/MMBtu \times GAS\ INPUT \times Btu\ CONTENT = \qquad LBS/HR$$

NMOC EMISSION RATE CALCULATION

FACILTY:

UNIT:

DATE:

RUN ID#:

START:

END:

Craw PPMwv   =

Cdry PPMdv   =

M.W. CH4   =

BWO %   =

Cgas % CO2   =

Cgas % O2   =

FUEL FACTOR(Fd)=

Qs DSCFH   =

$Cd = Cdry \ X \ (M.W./385.6) \ / \ 1,000,000 \ =$ LBS/SCF

$E = Cd \ X \ FUEL \ FACTOR \ X(20.9/(20.9-\%O2)) \ =$ LBS/MMBTU

$PMR = \ Cd \ X \ QS \ DSCFH$ =   LBS/HR

H2SO4 EMISSIONS CALCULATION SHEET

FACILITY: RUN ID#:
UNIT   :   START:
DATE   :   END:

SAMPLE ANALYTE SUMMARY REPORT   VOLUME
                                                                        (ml)

IMP 2,3,RINSE - MICROGRAMS PER MILLITER =   ug/ml

IMP 2,3,RINSE - MICROGRAMS PER SAMPLE   =   ug

TOTAL (ug) - MICROGRAMS PER SAMPLE   =   ug

MOLECULAR WEIGHT OF SULFURIC ACID (H2SO4)   =

BLANK ANALYTE SUMMARY REPORT   VOLUME
                                                                        (ml)

BLANK - MICROGRAMS PER MILLITER   =   ug/ml
TOTAL BLANK - MICROGRAMS PER SAMPLE   =   ug

VM STD $17.64 * (VM)*Y*DELTA\ H\ ABS) / (TM)$ =   DSCF

Qs $3600(1-BWO)(VS)(AS)(17.64)(PS)/(TS)$ =   DSCFH

CS $(2.205\ X\ 10-9)\ (ug) / (VM\ STD)$ =   LBS/DSCF

CS' $0.0000154\ (ug) / (VM\ STD)$ =   GRAINS
                                                                       /DSCF

                   CS * 1000000
PPMdv   ----------------   =   PPM
              (MW H2SO4) / 385.6

PPM $PPM * (20.9-15/20.9-\%O2)$ =   PPM
@ 15% O2   @ 15% O2

PPMwv $PPMdv * (1-BWO)$ =   PPM

PMR $(QS)\ (CS)$ =   LBS/HR

CYCLONIC FLOW TRAVERSE DATA

FACILITY: _____   DATE: _____

UNIT#: _____   RUN TIME: _____

RUN#: _____   STATIC P: _____

PITOT LEAK-TEST DATA

INITIAL RATE
PITOTS: _____

FINAL RATE
PITOTS: _____

TRAVERSE POINT	VELOCITY HEAD	ROTATION ANGLE	STACK TEMP F

METHOD 5 SAMPLING DATA SHEET

Facility: _____   Unit   : _____

Date   : _____   Run Time : _____

Run   : _____   Filter No. : _____
                              Nozzle No.: _____

Leak Test Data

Initial Rate: Final Rate:
Probe:_____ "Hg   Probe:_____ "Hg
Pitots:_____ "H$_2$O   Pitots:_____ "H$_2$O

Initial Meter Reading: | _____ |

Time Hr	Min	Trav. Point	Delta P	Delta H	Meter Vol.	DGM IN	DGM Out	Imp Temp	Stack Temp	Hot Temp	Pump Vac

General:	Operators:	Conditions:	Moisture		Gross	Tare	Net
Box No : _____	Box : _____	Ambient Temp:_____	Data:				ml
Delta H@:_____	Probe:_____	Pbar :_____					ml
Gamma Y:_____	CEMS:_____	Static P :_____					ml
							g

Calibration Error Test at Run 1
Operator: Sean MacKay
Plant Name:
Location:

Reference Cylinder Numbers

	Zero	Low-range	Mid-range	High-range
O2				
CO2				
CO				
NOx				

Date/Time				
Analyte	O2	CO2	CO	NOx
Units	%	%	ppm	ppm
Zero Ref Cyl				
Zero Avg				
Zero Error%				
Low Ref Cyl				
Low Avg				
Low Error%				
Mid Ref Cyl				
Mid Avg				
Mid Error%				
High Ref Cyl				
High Avg				
High Error%				

Error % = Ref Cyl - Avg / Span * 100
Error may not exceed 2%

Final System Bias Check for Run 1 . STRATA Version 1.1

Final System Bias Check for Run 1
Operator:
Plant Name:
Location:

Reference Cylinder Numbers
	Zero	Span
O2		
CO2		
CO		
NOx		

Date/Time				
Analyte	O2	CO2	CO	NOx
Units	%	%	ppm	ppm
Zero Ref Cyl				
Zero Cal				
Zero Avg				
Zero Bias%				
Zero Drift%				
Span Ref Cyl				
Span Cal				
Span Avg				
Span Bias%				
Span Drift%				
Ini Zero Avg				
Ini Span Avg				
Run Avg				
Co				
Cm				
Correct Avg				

Span Bias = (Avg-Cal) / Span * 100
Span Drift = (Ini Avg - Avg) / Span * 100
Correct Avg = (Run Avg - Co) * Ref Cyl / (Cm-Co)

METHOD 25A CALIBRATION ERROR DATA SHEET

FACILITY: _____   DATE: _____

UNIT ID: _____   OPERATOR: _____

START TIME: _____

RANGE OF INSTRUMENT: _____ PPM

THC	CYLINDER VALUE	ANALYZER RESPONSE	ABSOLUTE DIFFERENCE	% CALIBRATION ERROR
ZERO				
LOW				
MID				
HIGH				

CALIBRATION ERROR = The difference between the gas concentration indicated by the measurement system (analyzer response) and the known concentration of the calibration gas.

Calibration error may not exceed 5% of the calibration gas value.

METHOD 25A CALIBRATION DRIFT DATA

FACILITY: _____   DATE: _____

UNIT ID: _____

RUN#: _____   RUN TIME: _____

THC	CYLINDER VALUE	INITIAL RESPONSE	FINAL RESPONSE	DRIFT % SPAN
ZERO				
SPAN				

RUN#: _____   RUN TIME: _____

THC	CYLINDER VALUE	INITIAL RESPONSE	FINAL RESPONSE	DRIFT % SPAN
ZERO				
SPAN				

RUN#: _____   RUN TIME: _____

THC	CYLINDER VALUE	INITIAL RESPONSE	FINAL RESPONSE	DRIFT % SPAN
ZERO				
SPAN				

$$DRIFT = \frac{Absolute\ difference}{Range\ of\ Analyzer} \times 100$$

Drift may not exceed 3% of span value

METHOD 5 PRE-TEST CONSOLE CALIBRATION

USING CALIBRATED CRITICAL ORIFICES

6-POINT ENGLISH UNITS

Meter Console Information	
Console Model Number	
Console Serial Number	
DGM Model Number	
DGM Serial Number	

Calibration Conditions	
Date	Time
Barometric Pressure	
Theoretical Critical Vacuum[1]	
Calibration Technician	

Factors/Conversions	
Std Temp	
Std Press	
K₁	

[1]For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2]The Critical Orifice Coefficient, K', must be entered in English units, $(ft^{3.}°R^{1/2})/(in.Hg·min)$.

Calibration Data

Run Time		Metering Console				Coefficient	Serial Number	Critical Orifice		Actual Vacuum
	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final			Amb Temp Initial	Amb Temp Final	
Elapsed (Θ)	(P_m)	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})	K'		(t_{amb})	(t_{amb})	
min	in H₂O	cubic feet	cubic feet	°F	°F	see above2		°F	°F	in Hg

Results

Standardized Data				Calibration Factor		Dry Gas Meter Flowrate			
Dry Gas Meter	Critical Orifice			Value (Y)	Variation (ΔY)	Std & Corr $(Q_{m(std)corr})$	0.75 SCFM (ΔH@)	Variation (ΔΔH@)	
$(V_{m(std)})$	$(Q_{m(std)})$	$(Vcr_{(std)})$	$(Q_{cr(std)})$						
cubic feet	cfm	cubic feet	cfm			cfm	in H2O		
			Y Average					ΔH@ Average	

Note: For Calibration Factor 'Y', the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature _____ Date _____

NOZZLE CALIBRATION DATA

FACILITY: _____   DATE: _____

NOZZLE ID: _____

DIAMETER #	INSIDE DIAMETER (in)
1	
2	
3	
AVERAGE	

NOZZLE ID: _____

DIAMETER #	INSIDE DIAMETER (in)
1	
2	
3	
AVERAGE	

NOZZLE ID: _____

DIAMETER #	INSIDE DIAMETER (in)
1	
2	
3	
AVERAGE	

NOTE: The difference between inside diameters shall not exceed 0.004 inches

INTERFERENCE RESPONSE TEST

Date: _____   CEM System: _____

Calibration Span and Gas Values:

	CO	SO2	O2	CO2	NOx
Span					
Gas Value					

Analyzer Type: _____

Serial # : _____

Test Gas Type	Concentration (ppm)	Analyzer Response (ppm)	% of Span

$$\% \text{ of Span} = \frac{\text{Analyzer Response}}{\text{Intrument Span}} \times 100$$

Interference may not exceed 2 % of span

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NO2 to NO Converter Efficiency

Procedure: Introduce a concentration of 40 to 60 PPM NO2 to analyzer in direct calibration mode and record the NOx concentration displayed on analyzer.

Results:

Operator: _____

Date: _____

S/N _____

Start Time: _____

NO2 Gas Value: _____ ppm

End Time: _____

NOx Reading: _____ ppm

Efficiency % _____ %

$$\text{Efficiency \%} = 100 - \frac{(\text{NO2 Value} - \text{NOx Reading})}{\text{NO2 Value}} \times 100$$

Allowed Efficiency % = 90% or greater

360 Old Colony Road, Suite 1, Norton, MA 02766

RESPONSE TIME CHECK

Procedure: Introduce upscale gas at the probe upstream of all sample conditioning components in sytem calibration mode. Record the time it takes for the measured concentration to reach 95% or 0.5 PPM of the certified gas concentration. Next introduce zero gas and record the time It take to reach 0.5 PPM or 5% of upscale gas concentration.

Results:

Facility: _____

Date: _____

Gas Value: _____

Upscale Time: _____

Downscale Time: _____

Response Time: _____

Thermocouple Calibration Sheet

DATE: _____

TECHNICIAN: _____

ALL READINGS IN DEGREES FARENHEIGHT

T.C. ID	AMBIENT WATER	ACTUAL RESPONSE	BOILING WATER	ACTUAL RESPONSE	% DIFF LOW	% DIFF HIGH	RESULT
	32		212				
	32		212				
	32		212				
	32		212				

CEMServices

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S - TYPE PITOT GEOMETRIC CALIBRATION

PROBE IDENTIFICATION: _____

PITOT IDENTIFICATION: _____

TECHNICAL SPECIALIST: _____

CALIBRATION DATE: _____

PART 1 - PROBE CONFIGURATION

		RESULT
A.	Dt= _____	_____
	Dn = _____	_____
	a = _____	_____
B.	Pa= _____	_____
	Pb = _____	_____
	b = _____	_____
C.	c = _____	_____
	d = _____	_____
	e = _____	_____
D.	c = _____	_____
	f = _____	_____

PART 2 - PITOT ALIGNMENT

		RESULT
A.	a= _____	
	b= _____	
	c= _____	
	d= _____	
	e= _____	
	□= _____	_____
	□'= _____	_____
B.	a= _____	
	b= _____	
	c= _____	
	d= _____	
	e= _____	
	)= _____	_____
	)'= _____	_____
C.	f= _____	_____
D.	g= _____	_____

SPECIFICATIONS (EPA Method #2)

Dt = 3/16" to 3/8"	b >= 0
Dn = 1/2"	c,d >= 3"
* Pa = Pb	f >= 2"
a,e >= 3/4"	

SPECIFICATIONS (EPA Method #2)

80ø<□/□'< 100ø

85ø<)/)'< 95ø

f < 1/8"

g < 1/32"

* Slight misalignments of the openings are permissible.

If PART 2 - PITOT ALIGNMENT specifications are met,

then these will not effect the baseline value of Cp(s).

CEMSERVICES

360 Old Colony Road, Suite 1
Norton, MA 02766
508-226-6700

PRETEST PROTOCOL

**UGI DEVELOPMENT COMPANY HUNLOCK CREEK ENERGY CENTER
HUNLOCK CREEK, PA
CONTINUOUS EMISSION MONITORING SYSTEM
CERTIFICATION / RATA TEST PROGRAM
COMBUSTION TURBINE UNITS 5 & 6**

2011

Source Designation:
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Combustion Turbine 5 & 6
Hunlock Creek, Pa. 18621

Prepared for:
UGI Development Company
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Hunlock Creek, Pa. 18621

Prepared by:
CEMServices Inc.
360 Old Colony Road, Suite 1
Norton, Massachusetts 02766

Sean MacKay
Technical Director

1/4/2011
Date

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A - Definition of Abbreviations
B - Sample Calculation Sheets
C - Sample of Field Data Sheets
D - Sample of Reference Method Equipment Calibration Sheets

1. INTRODUCTION

The UGI Hunlock Development Company is repowering the Hunlock Creek Energy Center with two (2) new combustion turbine generators (CTG's) in combination with two (2) heat recovery steam generators (HRSG's) with a nominal output of 122 megawatts (MW). These systems are equipped with a Continuous Emissions Monitoring System (CEMS), installed by CEMTEK Environmental, that monitor the concentrations of Nitrogen Oxides (NOx), Carbon Monoxide (CO), Ammonia (NH3), and Oxygen (O2), in the combustion gases exiting the turbines.

As required by the State of Pennsylvania Department of Environmental Protection (PADEP), and 40 CFR 60, Standards of Performance for New Stationary Sources, Performance Specifications (PS) 2, 3, 4 and 40 CFR 75, Appendix A - Specifications and Test Procedures for Continuous Emissions Monitors, Hunlock Creek is required to perform a certification on the CEMS installed on each of the two (2) gas turbines in the form of a Relative Accuracy Test Audit (RATA).

This document is intended to satisfy the requirements of 40 CFR, Part 75 as well as NSPS 40 CFR, Part 60. Table 1-1 lists each requirement, who is responsible for performing the evaluation, the component of the CEMS to be assessed, and the applicable regulation:

TABLE 1-1
CERTIFICATION TEST REQUIREMENTS

REQUIREMENT	PERFORMED BY	COMPONENT	REQUIRED BY
Linearity Check	CEMTEK	O_2, NOx	40 CFR 75, App. A, Sect. 6.2
Response Time	CEMTEK	CO	Part 60 40 CFR 60, App. B, Spec. 4 Sect.13.3
Calibration Drift Test	CEMTEK	O_2, NOx,NH3, CO	Part 60 40 CFR 60, App. B, Sect. 4.2
Gas Fuel Flow Meter (GFFM) Certification	UGI Hunlock	GFFM	Will use 40 CFR 75, App. D, Sect.2.1.5 to demonstrate certification
RATA and Bias Test	CEMServices	O_2, NOx	40 CFR 75, App. A, Sect. 6.5
RATA	CEMServices	O_2, NOx, CO, NH3	Part 60 40 CFR 60, App. B, Sect. 5.3

1. INTRODUCTION (continued)

UGI Development Company has retained CEMServices of Norton, Massachusetts to perform the Certification RATA. As specified in 40 CFR 60, Appendix F, Relative Accuracy Test Procedures, CEMServices will conduct Reference Method (RM) tests and acquire emission data for comparison to data generated by the facility's CEMS. Megawatts (MW) will be used to document the facility load by the DAHS located in the control room. Facility data will also include NOx, CO, NH3, and O_2 values as recorded by the facility CEM. These documents will be available during testing.

Table 1-2 below is the Relative Accuracy Test Audit overview indicating the parameters to be tested, the US EPA test methodologies to be used, the emission standards and the allowable relative accuracy's (RA's) on each unit where applicable.

TABLE 1-2
UGI HUNLOCK CREEK RATA PROGRAM OVERVIEW

PARAMETER	TEST METHOD	ALLOWABLE RA		
		40 CFR 60	40 CFR 75 (semiannual)	40 CFR 75 (annual)
O2 (%)	EPA 3A and PS 3	20 % of RM or 1 % absolute O2 diff.	10 % of RM or 1 % absolute O2 diff	7.5 % of RM or 0.7 % absolute O2 diff
NOx (ppm @15% O2, lb/mmbtu, lb/hr)	EPA 7E and PS 2	20 % of RM or 10% of limit	10 % of RM or $\pm$ 0.020 lb/MMbtu	7.5 % of RM or $\pm$ 0.015 lb/MMbtu
CO (ppm @15% O2, lb/mmbtu, lb/hr)	EPA 10 and PS 4/4A	10 % of RM or 5% of limit or 5 ppm diff.	N/A	N/A
NH$_3$	CTM 027	N/A	N/A	N/A

Where:
>   RM = Reference Method Average
>   EM = Applicable Emission Limit

1. INTRODUCTION (continued)

In addition to meeting the RA requirements, the system must also meet the following performance specifications as shown in Table 1-3.

TABLE 1-3
CEMS CERTIFICATION PERFORMANCE SPECIFICATIONS

REQUIREMENT	GAS USED	COMPONENT	SPECIFICATION
Response Time	Protocol	CO	less than or equal to 1.5 minutes
GFFM Certification	-	GFFM	less than or equal to 2 %
Calibration Drift	Certified	NOx	2.5% of analyzer span
Calibration Drift	Certified	CO	2.5% of analyzer span
Calibration Drift	Certified	O2	0.5% O2

Sean MacKay, Project Director for this program, will be responsible for all phases of field-testing, data reduction, and report generation. A qualified engineer and technician will assist him. The contact at the facility is Jeff Steeber. Mr. Steeber can be reached at:

Jeff Steeber
Environmental Health & Safety
UGI Development Company
Hunlock Creek Energy Center
390 Route 11 PO Box 224
Hunlock Creek, Pa. 18621
Phone: 570-542-5369 Ext 232
Fax: 570-542-5643
email: jsteeber@ugies.com

2. FACILITY DESCRIPTION

A. General

The Hunlock Creek Energy Center is comprised of two (2) new 50 MW GE LM 6000 PC-Sprint combustion turbine generators (CTG's) in combination with two (2) heat recovery steam generators (HRSG's) with a nominal output of 122 megawatts (MW). Each turbine burns natural gas as the primary fuel and low-sulfur distillate as an optional fuel. The CTG's have water injection to control NOx emission. Each HRSG includes supplemental duct firing and a Selective Catalytic Reduction (SCR) module. A combination of combustion controls and oxidation catalyst is used to control carbon monoxide (CO) emissions.

The following are the emission limits for the CTG's.

TABLE 2-1
HUNLOCK CREEK ENERGY CENTER EMISSION LIMITS

PARAMETER	GT/HRSG FIRING GAS WITHOUT DUCT BURNER ppmdv @ 15% O2	GT/HRSG FIRING GAS WITH DUCT BURNER ppmdv @ 15% O2	GT/HRSG FIRING OIL WITHOUT DUCT BURNER ppmdv @ 15% O2	GT/HRSG FIRING OIL WITH DUCT BURNER ppmdv @ 15% O2
NOx	2.50	2.90	8.00	8.50
CO>32°F	4.00	4.00	6.00	6.00
CO<32°F	10.00	10.00	6.00	6.00
NH$_3$	27.7 Tons/yr 12-month rolling sum			

2. FACILITY DESCRIPTION (continued)

B. Continuous Emission Monitoring System

The CEMS at Hunlock Creek on monitors the Oxygen, Carbon Monoxide, Nitrogen Oxides, and Ammonia, from the exhaust of each of the CTG's. The system, installed by CEMTEK, is a dry extractive CEMS consisting of a sample line, sample gas conditioning system, analyzers and data acquisition system. LB/HR and LB/MMBtu emission rates are calculated using CEM monitor outputs and a signal from the fuel flow meter. Table 2-1 below lists the monitors that analyze the emissions from the facility.

TABLE 2-1
HUNLOCK CREEK ENERGY CENTER CEMS

Parameter	Range	Make	Model #	Serial #
UNIT 5 CEMS				
O_2	0-25%	Servomex	1440D	01440DIV02/4260
NOx	0-10 ppm 0-200 ppm	TECO	42i/LS	1009241446
CO	0-20 ppm 0-2000 ppm	TECO	48i	CM 10090038
NOx/NH3	0-20 ppm 0-200 ppm	TECO	42i/LS	1009241447
UNIT 6 CEMS				
O_2	0-25%	Servomex	1440D	01440DIV02/4261
NOx	0-10 ppm 0-200 ppm	TECO	42i/LS	1009241448
CO	0-20 ppm 0-2000 ppm	TECO	48i	CM 10090037
NOx/NH3	0-20 ppm 0-200 ppm	TECO	42i/LS	10090037

2. FACILITY DESCRIPTION (continued)

C. Test Location

The test platform is located at the 107 foot level. Four EPA test ports are located at the level for stack testing. A sketch of the sampling location is presented in Figure 2-1.
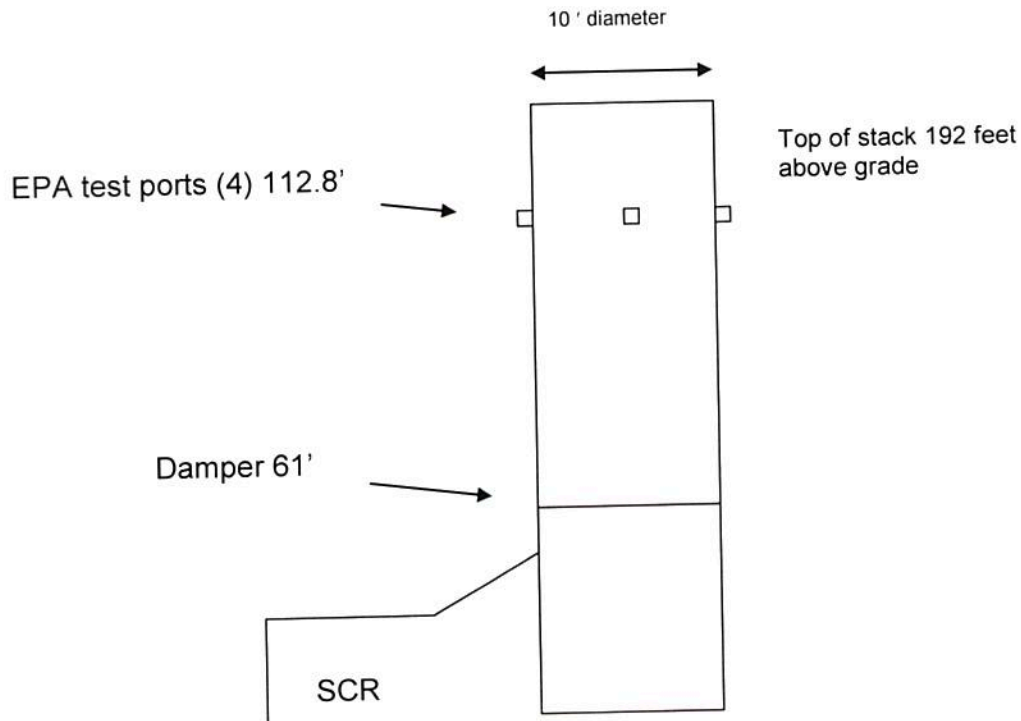
10 ' diameter

Top of stack 192 feet above grade

EPA test ports (4) 112.8'

Damper 61'

SCR

Figure 2-1
Hunlock Creek Energy Center
Sample Port Locations
Units 5 & 6

Figure not drawn to scale

Stack Height Above Grade - 192 feet
Stack Inside Diameter at Test Port – 10.0 ft

Disturbance Distances
       1. Above Grade 192.5feet
       2. Above Last Disturbance (damper to test ports)
           A. Feet – 51.8 feet
           B. Stack Diameters – 5.2
       3. Prior to Stack Exit (test ports to stack exit)
           A. Feet – 79.2 feet
           B. Stack Diameters – 7.9

3. REFERENCE METHOD TEST PROCEDURES

A. Relative Accuracy Test Audit

The data accuracy assessment of the CEMS will be conducted using a Relative Accuracy Test Audit. This audit will consist of comparing data generated by the facility CEMS to data acquired simultaneously using US EPA reference test methods. Nine (9) to twelve (12) test runs will be conducted. Each run will be 21-30 minutes in length. All testing will take place at the stack sampling location thus ensuring all data to be representative of the facility emissions. RA comparisons will be made in the following units: O_2 (%dv), CO (LB/MMBtu, LB/HR, and PPM @ 15% O_2), NOx (LB/MMBtu, LB/HR, and PPM @ 15% O_2) and NH_3 (LB/MMBtu, LB/HR, and PPM @ 15% O_2).

The clock time of the data acquisition system in the CEMServices mobile laboratory will be set exactly to the facility CEMS time. The start and stop time of each test run will be documented on the facility's data acquisition system. During each test run, all CEM and process operation data will be printed out.

B. Velocity Traverse - EPA Test Method 1

Method 1 procedures delineate velocity traverses for stationary sources. As based upon EPA Method 1 criteria, a total of sixteen (16) traverse points, four (4) points per each of the four (4) ports, will be used for particulate/volumetric flow rate determinations. The probe will be marked according to the measurements in Table 3-1.

TABLE 3-1
TRAVERSE POINT LOCATIONS

Traverse Point	Distance (% Diameter)	Distance from Wall (inches)
1	3.2	3.8
2	10.5	12.6
3	19.4	23.3
4	32.3	38.8

The pitots will be connected to a manometer using 1/8 inch ID Tygon tubing. These connections were checked for leaks before they are initially used and at the conclusion of each run.

C. Flow Rate - EPA Test Method 2

Method 2 will be used for the determination of stack gas velocity and volumetric flow rate. Before the velocity traverse is started, a leak check will be conducted on the pitots, and the manometer will be leveled. The velocity head and stack gas temperature will be recorded for each of the required sampling points. Simultaneous gas density (Method 3A) and stack gas moisture content (Method 4) testing will be conducted during every test run. Each test run will be twenty one (21) to thirty (30) minutes in length (1.3 to 1.9 minutes per point).

3. REFERENCE METHOD TEST PROCEDURES (continued)

D. Ammonia / Moisture Content - EPA CTM 027

Conditional Test Method 027 is used for the determination of moisture and Ammonia content in stack gas. This method consists of extracting a known volume of gas sample and quantifying the removed Ammonia portion of this sample.

Before each test run the sampling train will be prepared. First, an in-stack glass filter holder will be loaded with a glass fiber filter and glass sampling nozzle. This nozzle will be sized for isokinetic sampling. This filter holder will then be attached to a stainless steel sample probe with a glass liner and a Teflon lined stainless steel union. The probe will then be connected to the impingers using a Teflon jumper. The impingers used to remove condensate and Ammonia from the gas will be prepared as follows: A total of four impingers will be loaded according to the method. The first three impingers will be loaded with 100 ml 0.1 N H2SO4 and the fourth will be loaded with silica gel. The sampling train will be assembled and the sampling probe heated. The train will be checked for leaks by plugging the sample inlet and challenging the train with a vacuum of 15 inches of Hg. All leak rates will be below 0.02 CFM. The initial meter volume will be recorded and the probe will be positioned at the first of the sixteen required traverse points. Sampling will be conducted isokinetically for the entire thirty (30) minute run at the points listed in Table 3-1.

At the completion of each test run the final meter volume will be recorded and another leak check will be conducted. The in-stack filter and nozzle will be removed and the probe and jumper will be rinsed and recovered on the stack. The impingers will then be recovered and their final volumes recorded. The final volumes will be used to calculate the moisture content of the stack gas. All rinses will be added to the catch into one sample bottle for each test run. Samples will be sent to Enthalpy Analytical of Raleigh, North Carolina for analysis by Ion Chromatography.

E. Nitrogen Oxides and CEMS Calibration Procedures - EPA Test Method 7E

Method 7E is used for the determination of Nitrogen Oxides emissions from stationary sources using instrumental analyzer procedures. In addition, all calibration procedures and requirements for the other instrumentation methods used, Methods 3A, 6C, and 10 are specified in this method.

span or within 0.5 PPM, when compared to the analyzer calibration error check conducted Before any testing is conducted, the calibration span of all test analyzers will be set up so that expected source emissions will be at least twenty (20) percent of this span and will not exceed this span. Once this span is determined, calibration gases will be chosen within this span. Only gases prepared according to EPA Protocol G1/G2 will be used. Certificates of analysis for all gases will be provided on-site at the time of testing. Analyzer calibration error checks will then be conducted by challenging each analyzer with a zero, mid, and high gas. The actual value of the high gas used will be the calibration span of each analyzer. Analyzer responses to these gases will be within two (2) percent of the instrument's span or within 0.5 PPM of the gas value. Before and after each test run a sampling system bias check will be conducted on each monitor. This check will consist of introducing the calibration gases at the sampling probe thus allowing the gases to travel through the entire sampling system including any filters. The analyzer responses to this check will then be recorded by the data acquisition system. All system bias check responses will be within five (5) percent of the instruments initially.

3. REFERENCE METHOD TEST PROCEDURES (continued)

The sampling system bias check conducted prior to each test run will be compared to the sampling system bias check conducted at the completion of that same run.

Differences between the two bias checks constitute the upscale and zero calibration drifts. All calculated calibration drifts will be below three (3) percent of the span of the analyzer or within 0.5 PPM. Once the initial system bias check is conducted the system will be put into the sample mode and data acquisition will be initiated. The probe will be positioned at the first of the required traverse points.

To ensure that the NH3 in the stack gas (if applicable) will not be converted to NO, CEMServices will utilize a Model 300 Molybdenum converter. The Molybdenum converter is used to convert NOx to NO at a lower temperature (approx. 350 °C) specific to NOx, thus eliminating the conversion of NH3.

A Thermo Environmental Model 42 NOx/NO2/NO analyzer will be used to continuously measure the concentration of NOx in the effluent gas. The analytical technique of the analyzer is chemiluminescence. In the determination of NOx, the sample is routed through a molybdenum converter where the NO2 is disassociated to form NO. The sample is then passed through a reaction chamber where the NO is quantitatively converted to NO2 by gas phase oxidation with molecular ozone produced within the analyzer. In this reaction, the NO2 molecules are elevated to an electronically excited state, and then immediately reverted to a non-excited ground state. This reversion is accompanied by the emission of photons, which impinge on a photomultiplier detector and generate a low level DC current. The current is then amplified and used to drive a front panel LED display and data recorder. The NOx concentration measured by the instrument includes the contributions of both the NO in the effluent and the NO resulting from the dissociation of NO2. The efficiency of this converter will be checked prior to testing using the procedure specified in Section 8.2.4.1 of this Method.

A STRATA data shuttle will document voltage output from each monitor. This instrument sends all signals via a RS-232 cable to a computer for data archiving. Data points will be logged every two (2) seconds during each test run. At the test run completion, data will be transferred to a spreadsheet for determination of the raw run average. This data will be included in the final report. Results from the initial and final system bias checks will be used to adjust the raw run average to correct it for any deviations due to the system bias.

F. Oxygen and Carbon Dioxide - EPA Test Method 3A

Method 3A is used for the determination of Oxygen and Carbon Dioxide emissions from stationary sources using instrumental analyzer procedures. All calibration procedures and requirements for this instrumentation method are identical to those found in EPA Test Method 7E.

O2 content in the effluent will be determined by a California monitor which utilizes a micro-fuel cell that consumes O2 from the atmosphere surrounding the measurement probe. The consumption of O2 generates a proportional electrical current. This current is then amplified and provides a signal output of 0-1 V DC which corresponds to a full scale range of 0-25 % O2.

A California Analytical non-dispersive infrared analyzer is used to continuously measure the CO2 concentration in the effluent. The theory of operation for this analyzer is based

3. REFERENCE METHOD TEST PROCEDURES (continued)

on the principle that CO_2 has a unique absorption line spectrum in the infrared region. The instrument consists of an infrared light source, a chopper, a measurement cell, and a detector. The infrared light beam emitted by the source passes through the measuring cell, which is filled with a continuously flowing gas sample. The light beam is partially absorbed or attenuated by the gas species of interest in this cell before reaching the front chamber of the detector.

Both the front and rear chambers of the sealed detector are filled with a reference gas. The difference in the amount of light absorbed between the front and rear chambers are dependent of the concentration of the gas species of interest within the sample measurement cell. A pressure differential is thus created between the two chambers. This pressure difference is then observed as gas flow by the micro-flow sensor located in a channel connecting the two chambers. The resulting AC signal from the micro-flow sensor is rectified, amplified, and linearized into a DC voltage signal for output. An interference response check will be conducted on the O_2 and CO_2 analyzers prior to testing.

G. Carbon Monoxide - EPA Test Method 10

Method 10 is used for the determination of Carbon Monoxide emissions from stationary sources using instrumental analyzer procedures. All calibration procedures and requirements for this instrumentation method are identical to those found in EPA Test Method 7E.

A Thermo Environmental Model 48 Gas Filter Correlation (GFC) analyzer is used to continuously sample the CO concentrations in the gas stream. GFC spectroscopy is based on the comparison of the infrared (IR) absorption spectrum of the measured gas to that of other gases in the sample being analyzed. This technique is implemented by using a high concentration sample of the measured gas (i.e. CO) as a filter for the infrared radiation transmitted through the analyzer. Radiation from an IR source is chopped and passed through a gas filter alternating between CO and N_2 due to rotation of the filter wheel. The radiation then passes through an interference filter and on to an absorption cell.

The IR radiation exits the sample cell and falls on to an IR detector. The CO gas filter produces a reference beam which cannot be further attenuated by CO in the sample cell. The N_2 side of the filter wheel is transparent to the IR radiation and thus produces a measure beam which is partially absorbed by CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with is amplified and related to the concentration of CO in the sample cell. Other gases, which absorb the reference and measure beams equally, do not cause modulation of the detector signal leaving the GFC responding specifically to CO.

H. CEM Stratification Check

Before any reference method test data is taken, a CEM stratification check will be conducted to ensure that there is no stratification at the stack test location. Stratification is defined as a difference in excess of 10 percent between the average concentration of the stack and the concentration at any other point. To ensure stratification does not exist, CEMServices will conduct a 16-point CEM traverse using the points to be used in the flow traverse as specified in Method 1. Each point will be sampled for two (2) minutes.

3. REFERENCE METHOD TEST PROCEDURES (continued)

The facility-operating load will be used as a reference point to ensure process changes haven't occurred during the time needed to conduct the traverse. Once the traverse is completed, each point will be checked to see if it is within 10 percent of the average of all the points. Traverse points will be switched to 0.4, 1.2, and 2.0 meters from the stack wall for RATA testing if no stratification is found.

I. Response Time Tests

A response time test will be conducted on both ranges of the CO monitor at the facility using the procedures delineated in 40 CFR 60, Appendix B. This check will also be conducted by CEMTEK

To perform the response time tests, the CO, analyzer will be challenged with a zero and high level (50 - 100 % of span) calibration gas. Both the upscale and downscale cycle times will be determined. The response time to reach 95% of the gas value must be less than or equal to 1.5 minutes for each CO analyzer. All check gases will be introduced at the audit port fitting, the gases will then travel to the tip of the sample probe via a calibration line. An audit report will be printed out which will show the analyzer response every minute.

4. REFERENCE METHOD TEST EQUIPMENT

A. Flow and Moisture Sampling Train

All Method 1, 2, and Modified 4 testing, described in Section 3 will be conducted using a flow and moisture sampling train. The train, manufactured by Nutech, consists of the following components:

Meter Box - The meter box used for this program will be the Nutech Model 2010 - Isokinetic Stack Sampler. This box consists of a leak-free sample pump, a dry gas meter, a vacuum gauge, and a temperature readout. Thermocouples are mounted on the inlet and outlet of the dry gas meter to provide meter temperatures during testing.

Umbilical - The umbilical to be used in this program consists of a sample line, pitot lines, and thermocouple lines. These lines transport sample from the impingers to the meter box, indicate pressure difference at the pitots to the meter box, and carry temperature signals from the stack to the temperature readout in the meter box.

Condenser System - This system consists of four glass impingers placed in series and in an ice bath. The second impinger is of the Greenburg - Smith design, and the first, third, and fourth impinger is standard. When prepared for a test run, the first two impingers are loaded with 0.1 N H_2SO_4, the third is empty, and the fourth is loaded with a 500 g of silica gel.

Probe - The probe assembly to be used in this program consists of a set of "S" type pitots, a stack thermocouple, and a stainless steel heated probe.

B. Mobile CEM Laboratory

All reference test methods described in Section 3 will be conducted using the CEMServices mobile CEM laboratory. This laboratory consists of all analyzers and support equipment necessary to conduct the CEM sampling during this test program. The following is a description of each item that makes up the entire system:

Sample Probe - A seven foot heated stainless steel probe will be used for this test program. The probe is manufactured by Labyrinth Systems and has a filter at the end of it to remove particulate matter. The other end contains a heated three-way assembly. An extension will be added if the entire stack needs to be sampled due to stratification.

Particulate Filter - This in-stack filter is a Labyrinth Systems 5 micron sintered stainless steel filter.

Calibration Valve Assembly - The calibration valve assembly allows the CEM operator to chose between sample and system calibration. A three-way assembly is housed inside a heated (250 °F), water resistant box at the end of the probe. This assembly will be capable of blocking and introducing calibration gas into the system without pressurizing it.

Heated Sample Line - This heated jumper is ten (10) feet long and transports the gas sample to the moisture removal system. The jumper is temperature self regulating and will maintain a temperature of 250 degrees F.

4. REFERENCE METHOD TEST EQUIPMENT (continued)

Moisture Removal System - This system continuously removes moisture from the sample gas while maintaining minimal contact between the condensate and the sample gas. CEMServices uses an electric condenser consisting of three (3) stainless steel heat exchangers that are continuously drained of condensate by two (2) peristaltic pumps. The inlet to the system is connected to the heated sample line and the outlet is connected to the sample transport line.

Sample Transport Line - 3/8-inch OD Teflon tubing will be used to transport the gas sample to the mobile laboratory. Approximately one hundred (100) feet of tubing will be used.

Sample Pump - A dual headed diaphragm pump will be used to transport the gas sample through the system to the sample gas manifold. Air Dimension manufactures this pump and all parts coming into contact with the gas stream are either Teflon or stainless steel.

Sample Gas Manifold - This manifold consists of a series of valves and adjustable rotameters capable of setting and maintaining the desired backpressure and flow rate to the analyzers during both sampling and calibration.

Sample Gas Analyzers - CEMServices will use the following analyzers to complete this test program:

TABLE 4-1
REFERENCE METHOD ANALYZERS

Gas	Manufacturer	Model	Range
O2	California Analytical	100	0-25 %
CO2	California Analytical	100	0-20 %
NOx	Thermo Electron	42	0-10 PPM
CO	Thermo Electron	48	0-20 PPM

Data Recorder - All voltage outputs from the analyzer will be sent to a Strawberry Tree data shuttle. This data shuttle, hooked up in series with an IBM compatible computer and Hewlett Packard printer collects point data thirty times per minute and prints out one-minute averages for each run. All raw calibration and run data will be saved to a file and printed out.

C. Calibration Gases

All calibration gases used for this test program will be prepared according to EPA Protocol #1. As per EPA Test Method 6C for all O2, CO2, and NOx testing, all mid calibration gas values will be between 40-60 % of the analytical range of the analyzer, and all high calibration gases will be between 80-100 %. The zero calibrations (including calibration error check and system bias check) for all analyzers will be conducted using pre-purified grade Nitrogen.

4. REFERENCE METHOD TEST EQUIPMENT (continued)

Below is a sample list of the gases to be used in this test program:

TABLE 4-2
REFERENCE METHOD CALIBRATION GASES

Gas/Range	Allowable Values	Cal Point
O2	10-15	Mid
0-25 %	20-25	High
CO2	8-12	Mid
0-20 %	16-20	High
NOx	4-6	Mid
0-10 PPM	8-10	High
CO	8-12	Mid
0-20 PPM	16-20	High

5. QUALITY CONTROL PROCEDURES

A. General

Throughout all phases of this test program strict attention will be given to all phases of testing to provide the highest quality of results possible.

All of CEMServices test equipment is of the highest quality available and undergoes routine maintenance to ensure top operating condition. This includes meter boxes, thermocouples, barometers, pitot tubes and sampling nozzles.

Meter boxes are calibrated over a full range of flow rates against certified orifices every six months. Thermocouples are calibrated as specified in the EPA Handbook against a NBS traceable mercury in glass thermometer. Pitot tubes are visually inspected for conformance to the dimensions specified in EPA Method 2.

Trained personnel will conduct sampling with extensive experience in CEM sampling. All analyzers are tested for interference of other gas compounds at least once every six months. In addition, a converter efficiency check is performed on the NOx analyzer to ensure the proper conversion of NO2 to NO.

All sampling and analysis will be conducted in strict accordance with EPA test procedures (where available). The quality control procedures found in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems will be adhered to as well.

Analyzer calibrations will be performed at the beginning of each test day. System calibrations will be performed before and after each test run through the entire sampling system.

All calculations will be conducted in strict accordance with the equations found in the individual Methods. Calculations will be conducted on a computer and a person other than the original calculator will ensure that it is correct and will check the input data.

The entire staff of CEMServices is thoroughly familiar with all test methods used in this program and has extensive experience in source emission monitoring.

DEFINITION OF ABBREVIATIONS

ACFM	Flowrate reported in actual cubic feet per minute.
An	Area of the nozzle, cross-sectional, in square feet.
As	Area of the stack in square feet.
BWO	Water vapor in gas stream, proportional by volume.
CC	Percent error confidence coefficient (one tailed).
Cd	Conversion calibration for concentration (PPMdv to lbs/SCF)
Cgas	Final emissions data reported by CEMS, adjusted for calibration drift. Reported as ppm dry, proportional by volume.
Cm	Average CEM response to initial and final span gas system calibration.
Cma	Concentration of the calibration gases.
Co	Average CEM response to initial and final zero gas system calibration.
Craw	Raw emissions data reported by the CEMS, uncorrected for calibration drift.
Cwet	Final emissions data reported by CEMS, adjusted for calibration drift and water vapor. Reported as ppm wet, proportional by volume.
% CO	Percent of carbon monoxide in the flue gas.
% CO_2	Percent of carbon dioxide in the flue gas.
Cp	Pitot tube coefficient.
Cs	The concentration in the stack in pounds per standard cubic foot.
Cs'	The concentration in the stack in grains per standard cubic foot.
Cs' @ 12%	The concentration in the stack in grains per dry standard cubic feet corrected to 12% CO_2.
DELTA H	The pressure differential across orifice meter, reported in inches of H_2O.
DELTA H(ABS)	The pressure differential across orifice meter, absolute conditions in inches of mercury.
Dn (IN)	Diameter of the nozzle in inches.
DGM IN	Temperature of the dry gas meter inlet, reported in degrees Fahrenheit.
DGM OUT	Temperature of the dry gas meter outlet, reported in degrees Fahrenheit.
Ds (FT)	Diameter of the stack in feet.
DSCFH	Dry standard cubic feet per hour.
DSCFM	Dry standard cubic feet per minute.
DSCMH	Dry standard cubic meters per hour.
E	Emission rate in pounds per million Btu using F Factor of fuel burned.
END METER	The dry gas meter reading at the end of the test.
F FACTOR	The theoretical amount of air in dry standard cubic feet (DSCF) needed to combust a million Btu's worth of fuel.
GR/BHP-HR	Grams per brake horsepower hour.
IMP(FIN)	Final volume of absorbing solution in impinger.
IMP(INT)	Initial volume of absorbing solution in impinger.
INT METER	The dry gas meter reading at the beginning of the test.
% ISO	Variation of sampling from isokinetic conditions.
LB/HR	Pounds per hour.
LB/MMBTU	Pounds per million British Thermal Unit.
LB/SCF	Pounds per standard cubic foot.
Md (DRY)	The dry molecular weight of the flue gas in pounds per pound mole.
MI	Volume in milliliters.
Mg/M3	Milligrams per cubic meter.
Mn	Total particulate found in sample minus the acetone residue (blank). Reported in milligrams.
Ms (WET)	Wet or actual molecular weight of the flue gas in pounds per pound mole.
MW	Molecular weight
% N2	The percent of nitrogen in the flue gas.
NO. PTS	Number of traverse points.
% O2	% oxygen in the flue gas.
P BAR	Barometric pressure at test location.
PIT COEFF	Pitot tube coefficient (S Type=.84, standard=.99).
PPM	Parts per million.

DEFINITION OF ABBREVIATIONS

PPMdv	Parts per million - dry volume.
PPMwv	Parts per million - wet volume.
P STK	Static pressure of the stack in inches of water.
PMR	The pollutant mass rate in pounds per hour.
PS (ABS)	Absolute stack pressure in inches of mercury.
Pstd	Standard absolute pressure, (29.92 in. Hg).
Qs	The volumetric flow rate of the flue gas in dry standard cubic feet per hour.
RA	Relative accuracy.
RATA	Relative accuracy test audit.
RM	Reference Method.
Sd	Emission standard (allowable emission rate).
SQ ROOT	The square root of each velocity head measurement (Delta P).
SQRT DELTA P	The average of the square roots of the measured pressure drops.
Stack Temp	The temperature of the stack in degrees (°F) Fahrenheit.
TM (°F)	Average temperature of the dry gas meter in degrees Fahrenheit.
TM (°R)	Average temperature of the dry gas meter in degrees Rankine.
TS (°R)	The temperature of the stack in degrees Rankine.
VEL HEAD	The pressure drop measured across the pitot tubes.
VI (TOT)	The amount of water collected in the impingers in milliliters.
VM (CF)	The volume sampled through the dry gas meter in cubic feet.
VM STD	Volume sampled through the dry gas meter corrected to standard conditions.
VOC	Volatile organic compounds
VS	Velocity of the stack gas in feet per second.
VW STD	The amount of moisture collected, corrected to standard conditions.
Y	Dry gas meter calibration factor.

VOLUMETRIC FLOW AND MOISTURE CALCULATION SHEET

FACILITY:
UNIT   :
DATE   :

RUN ID# :
START TIME:
END TIME:

Ds (FT)		TRAV PT	DELTA P	SQ ROOT	DELTA H	DGM IN	DGM OUT	STACK TEMP
As (SQFT)								
Y =								

PIT COEFF

IMP-1 (INT)
IMP-2 (INT)
IMP-3 (INT)
IMP-4 (INT)

IMP-1 (FIN)
IMP-2 (FIN)
IMP-3 (FIN)
IMP-4 (FIN)

% CO2 (OUT)
% O2 (OUT)
% CO (OUT)
% N2 (OUT)

P BAR
PSTK

FINAL METER
INT METER
MID CHECK   AVG:
VM (CF) =

TS ('R)=   DELTA H (ABS) =
TM ('F)=   PS (ABS)   =
TM ('R)=   VI (TOT)   =

VM STD   =   17.64 (VM) (Y) (DELTA H ABS) / (TM)   =   DSCF

VW STD   =   .04707 (VI TOT)   =   CF

BWO   =   (VW STD)/(VW STD)+(VM STD)   =

1-BWO   =   1 - BWO   =

Md (DRY) =   .44(%CO2)+.32(%O2)+.28(%CO)+.28(%N2) =   LBS/LB

Ms (WET) =   Md(1-BWO)+18(BWO)   =   LBS/LB

G   =   SQRT (TS / PS / MS)   =

VS   =   85.49(CP)(G)(SQRT DELTA P)   =   FPS

Qs   =   3600(1-BWO)(VS)(AS)(17.64)(PS)/(TS)   =   DSCFH
                                                               DSCFM
                                                               ACFM
                                                               WSCFM

NOx EMISSION RATE CALCULATION

FACILTY: RUN ID#:

UNIT: START:

DATE: END:

Cgas PPMdv =   Cgas % CO2   =

PPMV @15% O2 =   Cgas % O2   =

M.W. NO2   =   FUEL FACTOR(Fd)=

BWO %   =   Qs DSCFH   =

$Cd = Cgas \times 1.194\ E\text{-}7$ =   LBS/SCF

$E = Cd \times FUEL\ FACTOR \times (20.9/20.9\text{-}\%O2)$ =   LBS/MMBTU

$PMR = CD \times QS\ DSCFH$ =   LBS/HR

CO EMISSION RATE CALCULATION

FACILTY: RUN ID#:
UNIT: START:
DATE: END:

Cgas PPMdv =   Cgas % CO2   =

PPMV @15% O2 =   Cgas % O2   =

M.W. CO   =   FUEL FACTOR(Fd)=

BWO %   =   Qs DSCFH   =

$Cd = Cgas \times (M.W./385.6) / 1,000,000 =$ LBS/SCF

$E = Cd \times FUEL\ FACTOR \times (20.9/20.9 - \%O2) =$ LBS/MMBTU

$PMR = CD \times QS\ DSCFH =$ LBS/HR

AMMONIA EMISSIONS CALCULATION SHEET

FACILITY: RUN ID#:
UNIT   :   START:
DATE   :   END:

SAMPLE ANALYTE SUMMARY REPORT   VOLUME
                                                             (ml)

IMP 1,2,3,RINSE - MICROGRAMS PER MILLITER =   ug/ml
DILUTION FACTOR =

IMP 1,2,3,RINSE - MICROGRAMS PER SAMPLE   =   ug

TOTAL (ug) - MICROGRAMS PER SAMPLE   =   ug

MOLECULAR WEIGHT OF AMMONIA (NH3)   =

BLANK ANALYTE SUMMARY REPORT   VOLUME
                                                             (ml)

BLANK   - MICROGRAMS PER MILLITER   =   ug/ml
TOTAL BLANK - MICROGRAMS PER SAMPLE   =   ug

$VM\ STD = 17.64 * (VM)*Y*DELTA\ H\ ABS) / (TM) =$ DSCF

FUEL FACTOR(Fd)=

GAS INPUT =   HSCFH

Btu CONTENT =   Btu / HSCF

$CS = (2.205\ X\ 10-9)\ (ug) / (VM\ STD) =$ LBS/DSCF

$CS' = 0.0000154\ (ug) / (VM\ STD) =$ GRAINS
                                                           /DSCF

$$PPMdv = \frac{CS * 1000000}{(MW\ NH3) / 385.6} =$$ PPM

$PPM\ @\ 15\%\ O2 = PPM * (20.9-15/20.9-\%O2) =$ PPM
                                                           @ 15% O2

$E=Cd\ X\ FUEL\ FACTOR\ X\ (\ 20.9/20.9-\%O2) =$ LBS/MMBTU

$PMR = LBS/MMBtu\ x\ GAS\ INPUT\ x\ Btu\ CONTENT =$ LBS/HR

CYCLONIC FLOW TRAVERSE DATA

FACILITY: _____ DATE: _____

UNIT#: _____ RUN TIME: _____

RUN#: _____ STATIC P: _____

PITOT LEAK-TEST DATA

INITIAL RATE
PITOTS: _____

FINAL RATE
PITOTS: _____

TRAVERSE POINT	VELOCITY HEAD	ROTATION ANGLE	STACK TEMP F

360 Old Colony Road, Suite 1, Norton, MA 02766

FLOW & MOISTURE SAMPLING DATA

FACILITY:_____

DATE: _____

RUN: _____

UNIT: _____

RUN TIME: _____

AUDITOR: _____

LEAK TEST DATA

INITIAL RATE

PROBE: _____ "Hg

PITOTS: _____ "H2O

FINAL RATE:

PROBE: _____ "Hg

PITOTS: _____ "H2O

TRAV POINT	DELTA P	STACK TEMP

initial:

TRAV POINT	DELTA P	DELTA H	METER VOL.	DGM IN	DGM OUT	IMPIN TEMP	STACK TEMP	PUMP VAC

GENERAL

BOX #: _____

DELTA H @: _____

GAMMA Y: _____

PBAR: _____

STATIC P: _____

OPERATORS

BOX: _____

PROBE: _____

CEMS: _____

MOISTURE DATA

	GROSS	TARE	NET
1	ml	ml	ml
2	ml	ml	ml
3	ml	ml	ml
4	g	g	g

Calibration Error Test at Run 1 . STRATA Version 1.1

Calibration Error Test at Run 1
Operator: Sean MacKay
Plant Name:
Location:

Reference Cylinder Numbers
Zero   Low-range Mid-range High-range
O2
CO2
CO
NOx

Date/Time				
Analyte	O2	CO2	CO	NOx
Units	%	%	ppm	ppm
Zero Ref Cyl				
Zero Avg				
Zero Error%				
Low Ref Cyl				
Low Avg				
Low Error%				
Mid Ref Cyl				
Mid Avg				
Mid Error%				
High Ref Cyl				
High Avg				
High Error%				

Error % = Ref Cyl - Avg / Span * 100
Error may not exceed 2%

Final System Bias Check for Run 1 . STRATA Version 1.1

Final System Bias Check for Run 1
Operator:
Plant Name:
Location:

Reference Cylinder Numbers
Zero   Span

O2
CO2
CO
NOx

Date/Time

Analyte	O2	CO2	CO	NOx
Units	%	%	ppm	ppm
Zero Ref Cyl				
Zero Cal				
Zero Avg				
Zero Bias%				
Zero Drift%				
Span Ref Cyl				
Span Cal				
Span Avg				
Span Bias%				
Span Drift%				

Ini Zero Avg
Ini Span Avg
Run Avg
Co
Cm
Correct Avg

Span Bias = (Avg-Cal) / Span * 100
Span Drift = (Ini Avg - Avg) / Span * 100
Correct Avg = (Run Avg - Co) * Ref Cyl / (Cm-Co)